

six in number and have two-celled anthers. The pistil, or female floral organ, is solitary, with a one-celled ovary and usually two (rarely one or three) styles and stigmas; the latter are usually feathery (plumose). The perianth or corolla of more showy flowers is often represented in grasses by some rudimentary appendages known as lodicules, usually two (sometimes three) in number, which are small, thin, more or less translucent scales (*B*). These help to force open the lemma and palca, at the time of anthesis, to aid in fertilization.

The spikelets are usually themselves aggregated into terminal spikes, panicles, and racemes (*D*, *E*, *F*).

The fruit of grasses is a caryopsis, the seed and fruit being united, the seed adhering throughout to the thin outer fruit-covering, or pericarp (*C*). The caryopsis may be free, as in wheat and dropseeds (*Sporobolus*), or tightly invested, as in three-awns (*Aristida*) and gramas (*Bouteloua*).

Grasses form a large natural family comprising about 600 genera. Of these about 150 genera and 1,500 species occur in the United States.


Our species represent 14 tribes, which are differentiated primarily on spikelet characters.

Use has been made in grass taxonomy by some modern investigators of the basic number, size, and changes in "arm"-length of the chromosomes. W. M. Myers, in *The Botanical Review* for June 1947, writes that, despite cer-

tain limitations, "chromosome numbers, size and morphology provide critical information regarding phylogenetic relationships when used in conjunction with morphological, geographical, and ecological studies."

Grasses, widely distributed and among the most numerous individually of all plants, often form savannas or pure grass types, of which the buffalo-grass-grama "shortgrass" areas known as the Great Plains of our Middle West are familiar examples. Grasses range in height from less than an inch to more than 100 feet. The greatest number of species is in the Tropics, but the greatest number of individuals is in cooler climates.

For those interested in studying grasses, an admirable introduction is Mrs. Agnes Chase's *First Book of Grasses*. Though long officially retired, Mrs. Chase works every day in her office in the Smithsonian Institution and maintains her world-wide interest in systematic agrostology.

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## THE MAIN GRASSES FOR FARM AND HOME

MAX M. HOOVER, M. A. HEIN, WILLIAM A. DAYTON, C. O. ERLANSON

**WHEATGRASSES** (*Agropyron* species) are hardy, drought-resistant, and versatile. They produce abundant forage that is acceptable to all classes of livestock. Most of them are perennial, with or without running rootstocks. Usually the culms (stems) grow erect. The spikes resemble wheat, hence the

scientific name, *Agropyron*, which is derived from *agri*os, wild, and *pyros*, wheat. In the United States, wheatgrasses have great value in the Northern Great Plains, the Intermountain region, and the higher altitudes of the Rocky Mountain States.

Some wheatgrasses form sod; others

grow in bunches. The sod-forming species are particularly valuable for erosion control. Germination of the seed, which usually is produced in abundance, is rapid and the young seedlings may become established in competition with weeds and other grasses. This seedling vigor permits the sowing of wheatgrasses with a minimum of seed-bed preparation. Often good stands have resulted when the seed was drilled in weeds or small grain stubble. Their ease of establishment and adaptation to many kinds of soils, moisture conditions, and extremes of climate make the wheatgrasses of first rank for use in plantings that are intended to protect the soil.

Early spring growth, with high production of lush forage at the season when most needed by overwintering livestock, is another good characteristic of these grasses.

The wheatgrasses have been used extensively for revegetating depleted range and abandoned farm lands. They are unexcelled for this purpose in the areas to which they are adapted. Seed is generally available, and successful methods of stand establishment are generally known and readily applicable. Many thousands of acres of previously cropped farm land in the Great Plains owe their present economic usefulness for grazing to these hardy, nutritious grasses.

The genus *Agropyron* contains approximately 150 species widely distributed in temperate regions of the world. About 100 species occur in Eurasia, 30 in North America, and most of the remaining in South America. The species probably familiar to most of us is *A. repens*, commonly called quackgrass, which invades our cultivated fields and gardens with such aggressive persistence that it has fully earned its place in the category of weeds. Its aggressiveness, however, has been put to good use in holding soil in conservation practices.

A few of the species are annuals for which no particular use has as yet been found.

None of the group has any long period of domestication behind it—the first cultivation reported dates no further back than 1895—although several of the species have long been recognized as valuable range grasses, both here and abroad. Others may furnish valuable breeding materials.

It has been demonstrated that two introduced species, *A. elongatum* and *A. intermedium*, will hybridize with common and durum wheats. Many promising possibilities are thus opened. Russian plant breeders say they have produced a perennial wheat from such crosses, but we have been unable to obtain material for trial.

#### CRESTED WHEATGRASS (*Agropyron cristatum*)

Crested wheatgrass is a hardy perennial bunchgrass that produces an abundance of both basal and stem leaves. The leaves, about one-fourth inch wide and 6 to 10 inches long, are flat, somewhat lax, and slightly hairy on the upper surface. The stems are fine and develop dense tufts about 2 to 3 feet high. The dense spikes are 2 to 3 inches long; the spikelets are closely crowded and tend to form comblike crescents.

Crested wheatgrass is well adapted to the cool, dry areas of the Northern Great Plains, the Intermountain Region, and the higher elevations of the Rocky Mountain States. It has a wide-spreading, deeply penetrating root system. Partly for this reason, it can survive cold and drought, withstand grazing, and compete with weeds and associated grasses.

Crested wheatgrass usually begins growth in early spring. It ceases to grow during long, hot, dry periods of summer, but it again makes growth when moist, cool weather returns. By producing forage in early spring and early fall, when the normal growth of native grasses has not yet begun or has ended, this grass provides succulent feed when it is most needed. High palatability, good quality, and good volume

of forage, combined with hardiness, drought resistance, and adaptation to widely different soil types, make crested wheatgrass one of the most valuable of forage grasses in this country.

Hay of excellent quality is obtained by cutting the plants early, just after heading and before blooming. If cutting is delayed the forage quickly becomes stemmy and less palatable. The better quality and greater feeding value of hay produced by early cutting more than offset its lesser quantity. Forage yields of crested wheatgrass are comparable to those of brome in the more moist parts of its range in the United States and are greater than those of brome in the drier parts.

Consistently good seed crops can be expected except when limited by drought. Average yields of 200 pounds of seed an acre on dry land—when planted in rows and cultivated—and about half that amount from solid stands on dry land have been reported.

The grain binder, combine, and swather have been used satisfactorily for seed harvest. The ordinary small grain thresher or combine with proper screen and air adjustments may be used for threshing the seed.

The normal time between seed ripening and seed shattering is about 2 weeks. When seed harvesting equipment (such as binders or swathers) is used, field harvesting operations can be started several days before the seed has ripened sufficiently for the most efficient operation of a combine.

Threshed material as it comes from the combine or thresher separator often contains large amounts of dirt, chaff, broken straw, and clusters of seed spikelets. Spikelet clusters can be broken up by processing the seed with a hammer mill. Clean seed of good quality may be obtained by removing all foreign material with an ordinary fanning mill. The number of clean seed per pound varies from 165,000 to 200,000. A bushel of clean seed with a purity of more than 90 percent and germination of 88 percent weighs about 22 pounds.

Crested wheatgrass seedlings resist drought and withstand competition from weeds and grasses if given sufficient protection during the first 2 years of their establishment. Time of seeding varies with locality and with purpose of seeding. If sufficient moisture is present in early fall, seeding can be started in September and continued until field operations are stopped by cold weather. In the southern range of this species, spring seeding is satisfactory.

Seedbeds may be well prepared or the seed may be drilled or broadcast directly in small grain stubble, weeds, or depleted native range cover. However, when the latter methods of seeding are used, one or more additional seasons of protection are often needed for the newly established seedlings to overcome the competition of associated vegetation and arrive at the stage of readiness for use by livestock. Hence, if it is urgent that the newly seeded area be available for use in the shortest possible time, it often pays to make the additional effort needed for preparing a clean, firm seedbed.

Satisfactory stands have been obtained from solid drilling or broadcast seeding at rates of 4 to 8 pounds of clean seed per acre, depending on the density of plant stand desired. Where seed production is the major purpose of the seeding, the most satisfactory results are obtained by seeding in rows, spaced to permit cultivation. Seeding rates of 2 to 4 pounds an acre are satisfactory in making these seedings.

Since the introduction of crested wheatgrass, many hundreds of successful seedings have been made and the area of adaptation of this grass is well established. Perhaps no other forage grass has filled such an important place in our revegetation program.

Crested wheatgrass was first obtained by the Federal Government in 1898 from an experiment station in Russian Turkestan, where it was already under test. Seed of the first introduction made little impression because most of it was dissipated in trials where the conditions were unfavorable.

A second and larger introduction from the same place in 1906 afforded a wider distribution of seed and, during the dry years between 1916 and 1921, the species began to attract attention in North Dakota for planting on abandoned wheat land. Commercial seed has been available since 1929.

It is long-lived; sometimes a stand is utilized as long as 25 years. Slender wheatgrass, by comparison, does poorly after about 5 years or so in permanent pastures.

Another species, *A. desertorum*, was apparently brought in with the seed of crested wheatgrass in 1906 and was for a long time thought to be only a strain of that species. The history of *A. desertorum* is similar to *A. cristatum* in the United States, the variety called Fairway being from *A. cristatum*, while the variety Standard is said to be derived from *A. desertorum*.

#### INTERMEDIATE WHEATGRASS (*Agropyron intermedium*)

Intermediate wheatgrass is a perennial sod-forming wheatgrass. In the few years since it was introduced by the Department of Agriculture from the Soviet Union, it has been tested extensively in the northern and central parts of the Great Plains and the Pacific Northwest. Under a wide variety of soil and climatic conditions, it shows great promise for use as a pasture and forage species throughout those regions. The species is more drought-resistant than smooth brome and somewhat less hardy and drought-resistant than crested wheatgrass.

The plants begin growth in early spring and reach a height of 3 to 4 feet before growth ceases in midsummer because of scarcity of moisture. The return of moisture and cool temperatures in the late summer brings good growth recovery.

The abundant leafy foliage is relished by all classes of livestock. Plant growth is vigorous. Established seedlings tend to form a full sod somewhat less rapidly than those of smooth brome

or western wheatgrass grown under like conditions of soil and moisture.

Seed production is dependable, particularly when plants are grown in rows to permit interrow cultivation. Seed yields of 300 pounds an acre have been had from row plantings. Seed may be harvested with standard farm equipment such as a binder, combine, or swather. As with other wheatgrass species, the quality of seed is improved by processing with a hammer mill and cleaning with a fanning mill.

Excellent seedling vigor permits relatively low seeding rates. This species has greatest promise for seeding in mixture with other adapted long-lived species for range and forage uses; its seed-producing qualities are so promising that the amount of seed needed for revegetation will no doubt become available in commercial quantities within the next few years.

#### WESTERN WHEATGRASS (*Agropyron smithii*)

Western wheatgrass (a drawing of which appears on the next page) is a native, perennial, sod-forming grass distributed generally throughout the United States except in the humid Southeastern States. It is most abundant in the northern and central parts of the Great Plains, where it frequently occurs as the dominant species in native plant associations. Plant growth is vigorous, with seed heads at a height of 2 to 3 feet and with leaves 8 to 12 inches long and less than one-fourth inch wide. The leaf blades do not droop but are more or less stiff and erect. The entire plant is usually covered with a grayish bloom, which gives it a distinctive coloration.

The seed heads are 2 to 6 inches long. Usually there is but one spikelet at each node of the rachis.

Although western wheatgrass is adapted to a wide range of soils (including alkaline soils), it seems to prefer the heavy soils characteristic of shallow lake beds or along intermittent swales and water courses that receive



excess surface drainage water. Under these conditions, western wheatgrass may be found in almost pure stands. It also occurs in nearly pure stands on abandoned cultivated fields where the original stand of wheatgrass was not entirely eliminated by cultivation. These "go back" fields are dependable for the production of hay or seed.

Western wheatgrass has several characteristics that make it exceedingly valuable for use in revegetation and erosion control. Its hardness and drought resistance and its capacity to spread rapidly by means of underground rhizomes are outstanding values for conservation. It is excellent for terrace waterways and contour strip plantings for erosion control. The extent of its underground rhizomes and roots depends on availability of moisture and on the soil fertility. Ordinarily these underground plant parts make a profuse, dense growth, resulting in a tough, fibrous sod that effectively binds the soil and offers protection from erosion.

Growth starts fairly early in the spring and continues until limited by shortage of moisture or by continued hot summer periods. Abundant forage is produced and is relished by all classes of livestock until it becomes harsh and woody during late summer.

Mature plants cure well into a palatable, nutritious forage that provides excellent winter grazing. Leafy, high-quality hay also may be produced if proper precautions are taken to cut the grass while it is still succulent, not after the leaves and stems become harsh and woody. Yield of hay depends upon moisture, particularly that available during the early part of the growing season. It is not uncommon to obtain yields of three-fourths ton per acre of nearly pure western wheatgrass hay from "go back" fields. Native undisturbed areas seldom produce this much hay unless they have especially fertile soil and abundant moisture.

Seed yields are variable. They are influenced by soil fertility and by abundance of moisture and cool tempera-

tures during the flowering stage of plant growth. Seed yields are more dependable if the plants are grown in rows and cultivated. Yields of 200 pounds of seed per acre have been obtained under these conditions, whereas yields of seed harvested from native stands are seldom more than half as great.

The seed may be harvested with a binder, a combine, or a swather. As in the case of crested wheatgrass, it is often found advantageous to use the binder or swather for the early stages of seed harvest and increase the normal 2- to 3-week harvest period.

Threshed material as it comes from the combine may contain excessive amounts of dirt, chaff, spikelet clumps, broken straw, and weed seeds. These may be removed by use of the ordinary fanning mill. In some instances it may be necessary to process the seed with a hammer mill to break up the clumps of spikelets. When the mill is properly adjusted as to screen size, air volume, and speed, seed of very high quality and purity should be obtained.

The number of clean seed per pound ranges from 100,000 to 125,000. Clean seed weighs about 20 pounds a bushel and has an average purity of 88 percent and a germination of 80 percent. Seed of the western wheatgrass, like that of many other native grasses, has low germination immediately after harvest. Its dormancy can ordinarily be overcome by 6 months to 1 year of dry storage.

Very good stands of western wheatgrass have been obtained from solid drill or broadcast seedings at the rate of 6 to 12 pounds of clean seed per acre. Best results have been obtained when seedings were made on well-prepared, clean seedbeds. Because the young seedlings are small and inconspicuous, the new stand often appears disappointing; but with full protection from grazing until the second growing season, the stand improves rapidly in vigor and density.

Western wheatgrass seedlings are drought-resistant. They compete fairly

well with weeds and other grasses, although not so well as crested wheatgrass. The plants spread rapidly by means of underground rhizomes. Thus, if seeding results in a relatively thin stand, the spread will soon provide the density of cover desired. The sod-forming habit of western wheatgrass also provides a means of vegetative propagation on desired areas. The usual procedure is to start the new planting by use of sod pieces 3 or 4 inches square. This is an effective method of establishing a dense sod cover for a diversion channel, terrace, water outlet, or contour strip.

Its growth characteristics, drought resistance, hardiness, and wide adaptation to soil and climatic conditions make western wheatgrass one of the best grasses for revegetation and general farm use. Many acres of range and previously cropped farm lands have been seeded to this grass alone or in combination with other adapted forage grasses. Shortage of seed supplies has often limited the use of this grass.

#### BLUEBUNCH WHEATGRASS (*Agropyron spicatum*)

Bluebunch wheatgrass, a native, perennial, drought-resistant bunchgrass is found chiefly in the dry, open areas of the western United States. It is the climax herbaceous species of the native vegetation of the Pacific Northwest and Intermountain States where it forms as much as 60 percent of the vegetative cover in many localities. Its abundance, general distribution, drought resistance, and dependability as range forage make it important in the two regions.

The vigorous plant growth starts rather early in the spring if enough moisture is available. The leaves are flat, rather lax, about  $\frac{1}{4}$  to  $\frac{1}{2}$  inch wide and 6 to 10 inches long. The volume of forage produced is usually high and dependable. The leafage remains green throughout the growing season and is nutritious and palatable even after growth ceases, although the

stems become wiry late in the season. Plants may reach a height of 4 feet. Seed heads are about 6 inches long; the fairly dense spikelets have prominent divergent awns.

*Agropyron inerme*, beardless bluebunch wheatgrass, is closely related to bluebunch wheatgrass and differs only in that it lacks the awned spikelets. Many stockmen prefer it for the reason that lack of awns makes the plants more palatable, especially during the late stages of growth.

Both of these wheatgrasses are propagated only from seed. Deferring grazing until seed maturity, thus utilizing livestock for scattering the seed and trampling them into the ground, has been practiced to good advantage in some places. Many successful plantings have been made in revegetation work on range and farm lands in the Pacific Northwest.

Seed production from native stands is erratic. It depends upon moisture conditions during the spring months and upon cool temperatures during the critical period of blooming. These species produce seed satisfactorily when grown under cultivation; yields of more than 250 pounds per acre have been reported.

Seed may be harvested with a binder, a combine, or a swather, equipment that is most effective when the seed crop is grown under cultivation in rows. Native stands frequently occur on sites that are too rough, stony, and uneven for use of machinery; under such circumstances seed heads may be collected by means of a hand stripper or sickle. Mowing mature seed hay and subsequently scattering this seed material on a prepared seedbed has been practiced satisfactorily on areas that are not too extensive.

As seed material comes from the thresher or combine it often contains excessive amounts of dirt, chaff, straw, and other inert material. The divergent awns of bluebunch wheatgrass often are a great hindrance to the handling of this seed in drills of standard make. Processing the seed material

with a hammer mill to remove the awns results in a clean seed product that can readily be drilled with standard seeding equipment. This processing is not costly, and the improved quality of seed more than pays for the small additional cost of time as well as labor.

Considerable progress has also been made in breeding and selecting improved strains of these species. Adequate and dependable sources of seed have not been developed, however; therefore, field plantings remain on a relatively small scale. Farmer seed producers and commercial seedsmen are endeavoring to produce seed of improved adapted strains under seed certification.

#### SLENDER WHEATGRASS

(*Agropyron trachycaulum*)

Slender wheatgrass is a native perennial bunchgrass distributed throughout the United States except in the Southeast and South Central States. It is most prevalent throughout the Northern Great Plains and the Rocky Mountain States. It commonly grows to a height of 3 feet, and the dense, leafy bunches may reach a foot or more in diameter. The leaves are from 3 to 13 inches long and about  $\frac{1}{4}$  inch to  $\frac{1}{2}$  inch wide. Most of the leaves are basal, although there are quite a few stem leaves. The bunches enlarge by tillering, and propagation is entirely by seed. It is native to the Northern States and Canada. It was the first species to be cultivated and is one of the few native grasses that have become of commercial importance.

Although slender wheatgrass occurs on most soil types, it prefers the lighter soils, the sandy loams. It is less drought-resistant than either crested wheatgrass or western wheatgrass.

The flowering stems, erect and coarse, are numerous. The spikelets are usually not awned; this gives the seed head a characteristic slender appearance that distinguishes this grass from the other wheatgrasses.

Slender wheatgrass begins growth rather early in the spring and provides an abundance of palatable forage that is well liked by all classes of livestock. The forage cures well on the ground and furnishes considerable quantities of nutritious feed for winter grazing. The plants are not so resistant to close grazing as sod-forming species such as western wheatgrass, and careful management is required for most satisfactory grazing returns.

Good yields of high-quality hay are obtained if the plants are cut before the foliage becomes harsh and woody. The plants are relatively short-lived, and stand density decreases rapidly after the fourth production year. On the other hand, seedling vigor is exceptionally good and excellent vegetative cover is provided a few weeks after planting. These characteristics, combined with the relatively short life of the plants, suggest using this grass in mixture with other adapted grasses that are slow to become established but persist once they have done so.

Good crops of high-quality seed are usually obtained, particularly when this grass is grown in rows and cultivated. Seed yields of 200 to 300 pounds an acre have been produced under these conditions. Seed harvested from native stands seldom amounts to more than half this yield. There are between 140,000 and 160,000 clean seeds per pound, and a bushel weighs approximately 18 pounds.

Seed may be harvested with a binder, a combine, or a swather. Since seed heads shatter when fully ripe, it is often advantageous to make use of the binder or swather to lengthen the normal period of harvest. Combine-run seed usually contains excessive amounts of dirt, chaff, straw, and weed seeds; therefore, it is desirable to improve the quality of harvested seed by careful cleaning with a fanning mill.

Seeding at rates of 8 to 12 pounds per acre has resulted in good stands. The amount of seed should be adjusted in accordance with the kinds of species when mixtures are seeded.

When it is seeded with mixtures of other adapted species, particularly those having greater permanency of stand, this native species has a leading place in the revegetation of range and abandoned farm land. It is adapted to a wide range of soils and climates, and the forage is palatable to all classes of livestock. These desirable characteristics should encourage its more extensive use.

## THE BENTGRASSES

(*Agrostis* species)

The name *Agrostis* is assigned to the genus that includes the bentgrasses and redtop. It is an ancient Greek name for a forage grass, from *agros*, a field. To all but one of the subdivisions or species the common name bent is applied, the exception being the species known as redtop. The creeping habit of growth is more or less characteristic of all species, including redtop. All are low to moderately tall annuals or (more usually) perennials.

Redtop is a perennial with a creeping habit that makes a coarse, loose, turf. It matures about the same time as timothy. The leaves are about one-fourth inch wide. The stems are slender. The panicle is loose, pyramidal, and usually reddish. Redtop is widespread in the United States; it grows from Canada to the Gulf of Mexico and from New York to California.

Many common names other than redtop have been assigned to it—whitetop, florin, white bent, Herd's grass, and others. Because all these names belong more properly to other grasses, they should not be used for redtop.

Of the many grasses of the genus *Agrostis*, redtop is the only one of much prominence for hay. It is used in pasture mixtures under humid conditions, as a soil binder, and as a winter lawn and golf-green grass in the Southeast. It ranks among the lowest of our standard northern pasture grasses in palatability, but it is valued in pasture mixtures because it comes



Creeping bent

quickly and vigorously and helps to form a compact turf that protects the soil until the slower growing grasses become established.

Redtop has outstanding ability to grow under a variety of conditions. It is one of the best wet-land grasses, but it also resists drought and will grow on soils so low in lime that most other grasses fail. The strength and the rhizomatous character of the roots make it useful for holding banks to prevent erosion. It will add to the yield of timothy and clover hay, but buyers of market hay find it objectionable.

Because the seeds are small, the best results are obtained from planting on a compact, well-prepared seedbed. Redtop is usually sown broadcast, 8 to 15 pounds to the acre when seeded alone. In a mixture, 2 to 4 pounds are commonly used. Fall is considered the best time for seeding.

The crop will persist for several years, depending upon the fertility of the soil and the management. It is ideal for use in lawn mixtures where quick establishment is desired because



Colonial bent

it germinates rapidly but does not offer extreme competition to the slower growing, more permanent grasses. Redtop is seldom seeded alone.

Practically all the seed is produced in southern Illinois and parts of Missouri. The seed-producing fields remain for several years, depending upon management; the average duration in Illinois is 6 years. Seed fields that are pastured intermittently remain pro-

ductive longer and produce more seed. Grazing keeps them from becoming infested with weeds. Seed yields vary from season to season, but the average is about 55 pounds an acre. There are approximately 5,740,000 seeds in a pound; 14 pounds is the average weight of a bushel. Redtop seed will maintain viability for about 2 years.

The fine bentgrasses—colonial bent (*Agrostis tenuis*), creeping bent (*A. palustris*), and velvet bent (*A. canina*)—have been found well adapted for putting greens and, in mixtures with other grasses, for lawns over much of the northern half of the United States. For many years they have made beautiful lawn turf in New England.

Of the many strains of creeping bentgrass, most must be started by planting pieces of the stolons or runners because no seed is available. Washington creeping bent and Metropolitan creeping bent were the first named strains; many different strains now available are being used on putting greens. Seed of Seaside bent, also classed as creeping bent, is commercially available.

Velvet bentgrass (*A. canina*) is a fine-leaf type commonly found in rather limited districts in old turf. It is propagated from stolons, as are some varieties of creeping bent. Seed also is commercially available.

The bentgrass most generally used in lawn mixtures is commonly known as colonial bent (*A. tenuis*). It does not creep extensively; partly for that reason it needs less attention than the creeping bents. Astoria bent is essentially the same as the common colonial bent. Highland bent is classed as a variety of colonial bent but has a slightly different color and growth habit than the common colonial bent. All the colonial bents have given good results in lawn mixtures. They are affected by large brown patch, a fungus disease, and where they are grown alone they are likely to be injured by the disease.

The seeds of the bentgrasses run about 8 million to the pound.

## MEADOW FOXTAIL

*(Alopecurus pratensis)*

Meadow foxtail, a native of the temperate parts of Europe and Asia, has been cultivated since about 1750. Some of the earliest records indicate that it was recommended by Kalm in Sweden and Schreber in Germany in the middle of the 18th century, about 100 years before it was introduced into the United States.

A long-lived perennial, meadow foxtail resembles timothy in head so closely that it is often mistaken for it. The rootstocks are short (2 to 4 inches) and are comparatively few, as are the underground branches. The individual plants are generally in loose tufts, however, and old, heavy stands will produce medium dense sods. The flowering stems are erect and usually about 3 feet high; rarely they grow to 6 feet. The leaves are dark green, medium broad, and numerous.

The seeds are usually light in color. Occasional plants produce brown or black seeds. The caryopsis is enclosed in a light, fluffy, membranous covering.

Meadow foxtail is one of our earliest cultivated grasses. Growth begins in early spring. Flowering stems vary with climatic conditions. In places where winters and early springs are mild, a succession of flowering stems is produced from late in the winter to early summer. That is one of several characteristics that make this grass outstanding and versatile.

Cool, moist, climates are conducive to best growth of meadow foxtail. It is not sensitive to heat or cold, and succeeds in areas where summer temperatures occasionally reach 100° F. and where winter temperatures drop below zero for relatively long periods. Continuous winter growth often occurs where mean minimum temperatures are 40°. Soil moisture is the limiting factor during periods of high mean maximum temperatures, and usually growth is checked at these times. It is definitely not a southern grass but is

adapted to the moist, cool climates of southern Canada and the Pacific Northwest. It also appears to have possibilities as a forage grass in several sections of the northern half of the United States.

Meadow foxtail is naturally a wet- or moist-land grass and makes its best growth on fertile or swampy soils. It is used extensively on diked lands near the coast in the Pacific Northwest. The occasional overflow of brackish water does little or no damage to established stands. It is quite tolerant to saline soils, but that tolerance depends largely on soil moisture. It responds to irrigation in cool climates and is adapted to irrigated pastures when seeded alone or in mixtures of other grasses and legumes.

Both fall and spring seedings are successful in the Pacific Northwest. Generally, in most sections where it is adapted, spring seeding is the most satisfactory on cultivated lands.

When it is seeded in combination with other grasses and legumes, 3 to 5 pounds of seed of meadow foxtail is usually used per acre. But allowances should be made for its extreme variability in germination; when only low-quality seed can be had, the rate of seeding should be increased.

Meadow foxtail is primarily a pasture grass. Its long life, long grazing season, winter hardiness, and succulent forage make it a valuable pasture grass where it is adapted. It is seldom used for hay, but the hay is leafy and palatable to all kinds of livestock. In Oregon its hay yields sometimes average about 1½ tons an acre for one cutting.

In the coastal sections of the Pacific Northwest for a number of years, meadow foxtail, in combination with various grasses and legumes, has been made into silage. We have no reports of silage made from pure stands of meadow foxtail.

Most of the seed is imported or produced in Oregon. Seed supplies have generally been ample despite low yields and difficulty in cleaning. Yields of seed vary from 25 to 300 pounds an

acre, with an average of approximately 100 pounds. A bushel of seed weighs from 6 to 12 pounds. The seeds vary considerably in size, depending on quality; a pound contains 500,000 to 1,000,000 seeds.

Only to a limited extent do insects attack meadow foxtail in the humid climates. Slugs and cutworms cause some damage. In dry climates, especially late in the growing season when grasshoppers are numerous, considerable damage is caused. Occasionally aphids attack the green heads. No troublesome diseases have been noted, but ergot (*Claviceps purpurea*), scald (*Rhynchosporium orthosporum*), and stem rust (*Puccinia graminis*) have been observed on this plant.

## THE BEACHGRASSES

(*Ammophila* species)

The grasses of the genus *Ammophila* provide protection for sandy coastal areas. They derive their name from the Greek, *ammos*, sand, and *philos*, loving. They are tough, coarse, erect perennials with hard, scaly, creeping rhizomes and dense, spikelike panicles. They produce heavy growth on unstable beach sand of low fertility.

The normal spread of plants from rhizomes is rapid, and the young plants are well able to withstand the cutting effect of wind-driven sand particles without serious injury.

Beachgrass should be considered primarily for the special purpose of erosion control on eroding sandy areas. Such planting sites should be completely protected from livestock because the trails formed by grazing animals frequently are the first cause of serious blow-outs. The capacity of beachgrasses to provide initial stabilization on shifting dune areas and the rapid accumulation of organic matter from their leafy foliage are outstanding qualities.

European beachgrass, *Ammophila arenaria*, is a robust perennial with deep, extensively creeping rhizomes. It is native to the coastal sands of

northern Europe. The species has become well established at points along our Atlantic and Pacific coasts. The plants normally grow 5 feet high and produce large amounts of harsh, tough basal foliage. The root system is deep, with extensive rhizomes. The spike-like panicles are about 12 inches long, but viable seed are seldom produced.

American beachgrass, *Ammophila breviligulata*, occurs on the shores of the Great Lakes, along the Atlantic coast from Newfoundland to North Carolina, and sparingly along the Pacific coast. It resembles European beachgrass except for the smaller size of its ligule.

Both species have been used extensively for initial stabilization of moving sand on coastal areas. The most effective method of revegetation is by transplanting parts or clones of established plants. Clones for new planting are obtained by undercutting the old plants and separating the stems into convenient sizes for transplanting. Small buds, hidden by the lower leaf sheaths and occurring at the base of the stems, can form new plants and are an essential part of any vegetative material used to reproduce new plants.

Planting stock should be collected during the cool, wet months from late fall through early spring at a time when the plant is most nearly dormant. For convenience in handling, the culms are cut back to an over-all length of about 20 inches. These are set in hills on the new site, usually 3 to 5 culms per hill spaced at 2- to 3-foot intervals, with about 12 inches of the culms left standing above the surface.

The success of beachgrasses as sand stillers is due to the mechanical effect of the coarse stems that are allowed to project above the surface and give it protection against scouring; their rapid growth—2 feet or more in a single season—through heavy deposits of sand; the rapid multiplication of the stems from underground buds, so that large clumps soon are formed; the development of an extensive root system; and, in some cases, the pro-

duction of horizontal underground stems capable of growing into unvegetated areas and producing new clumps.

Permanent grass or woody species should be the ultimate vegetative goal, but the beachgrasses are unexcelled for the special purpose of initial sand stabilization.

## THE BLUESTEMS

(*Andropogon* species)

The *Andropogon* genus comprises a large group of species and is well represented throughout the world's warmer regions. The name, from the Greek *andros*, man's, and *pogon*, beard, alludes to the villous sterile pedicels.

Stems of *Andropogon* species are solid or pithy, differing in this respect from those of most other grasses, which are hollow. Two spikelets are produced at each node of the rachis. One spikelet is sessile and produces seed; the other is stalked but infertile.

Several species are regarded as good forage grasses because of their wide natural occurrence and dependability. Big bluestem, *A. gerardi*, and little bluestem, *A. scoparius*, are perhaps the most prevalent constituents of the wild hay of the prairie States. They are valued highly for grazing, although they are much less palatable as they mature.

Broomsedge, *A. virginicus*, also has a wide natural distribution and produces vegetative cover on soils of very low fertility. The palatability of broomsedge is poor; therefore it ranks low as a livestock forage. But its wide occurrence and persistence on worn-out, unproductive, sterile soils contributes materially to the protection of these sites.

### BIG BLUESTEM

(*Andropogon gerardi*)

Big bluestem is a vigorous, coarse, perennial native bunchgrass that occurs widely over most of the United States. Its major distribution is in the region of the tall-grass prairie in the Central States and along the eastern edge of the Great Plains.



Big bluestem

Plants usually grow 6 feet tall under favorable conditions of soil and moisture. Although short rhizomes are present, it usually makes a bunch type of growth. Leaf blades are about 12 inches long and from one-fourth to about one-half inch wide.

The leaves may be hairy near the base, and the sheaths are usually hairy. The flowering stalks are stout, coarse, and solid; the stalks of most other grasses are hollow. The extensive root system penetrates deeply. The grass grows well on most soil types but is most abundant on moist, well-drained loams of relatively high fertility.

Growth starts in late spring and continues throughout the summer. The abundant, leafy forage is palatable to all classes of livestock. It makes good-quality hay if mowed before the stemmy seed heads have formed. Much of the native hay marketed in the Mid-

west consists of big bluestem and associated species.

Successful plantings of big bluestem have been made on many soil types. The species may be seeded alone or in mixture with other adapted grasses. It has been planted chiefly to retire cropped land for permanent meadow or pasture use. The vegetative cover offers good surface protection. Seedings should be made on a well-prepared, firm seedbed free from weeds. Seeding rates of 15 pounds of good seed an acre have given excellent results. Full protection during the period of establishment is necessary; weeds should be mowed to lessen the competition for water and nutrients.

Big bluestem seldom produces seed every year, because the combination of plentiful moisture and moderate temperatures at the critical time of blooming does not occur regularly. When it is grown in rows and cultivated, however, it consistently produces 150 to 200 pounds of seed an acre. The seed normally matures in late September and October.

Ordinary binders and small-grain combines have been used satisfactorily to harvest the seed. Seed material as it comes from the combine or thresher usually contains excessive amounts of stems, chaff, and other inert matter. The material should be cleaned with a fanning mill. If cleaning is done satisfactorily, the seed should have a purity of at least 40 percent and a germination of about 60 percent.

#### LITTLE BLUESTEM (*Andropogon scoparius*)

Little bluestem is a vigorous, long-lived, native bunchgrass of wide distribution over the United States. It is most prevalent in the Great Plains, particularly in the Flint Hill sections of Kansas and Oklahoma, where it supplies dependable grazing and cured forage. But in many areas it is not considered of major economic value because of low palatability and poor quality of its forage as the plants mature.



Little bluestem

Little bluestem is smaller than big bluestem. The two usually are found in close association, but little bluestem is more drought-resistant and is better adapted therefore to sites that receive limited moisture.

Growth begins late in the spring and continues through the summer. Plants usually grow 1 to 3 feet tall. The leaf blades are less than  $\frac{1}{4}$  inch wide and from 4 to 8 inches long. The leaves, flattened at the base, are light green until the plants reach maturity, when they develop the distinctive reddish-brown color.

Because of its habit of growth and the wide range of soils on which it thrives, little bluestem has great value for erosion control. It is suitable for use in crop rotations and in mixtures for regrassing abandoned cultivated land. Seedings should be made on a well-prepared, firm seedbed free from weeds. A seeding rate of 15 pounds an acre has given good results.

Seed matures in late September and

October. The amount of seed produced in native stands depends on timely rainfall during the growing season, the reserve moisture, and favorable temperatures during the period of seed development. Because of these requirements, dependable seed harvests seldom occur in any area in successive years. If it is grown in rows and cultivated, however, it sometimes yields 200 pounds or even more of seed to the acre.

Seed can be harvested with a binder, combine, or swather. The seed units of little bluestem are light and chaffy, with awned appendages, and the seed material as it comes from the combine or thresher requires additional cleaning before it can be seeded with farm drills. The ordinary farm hammer mill has been found useful in processing the seed material.

By processing it with a hammer mill and cleaning it with a fanning mill to remove seed appendages and break up excessive stems and straw, a seed product of satisfactory quality can be obtained.

Seed purity of at least 40 percent and germination of 60 percent should be obtained by properly processing and cleaning the thresher-run seed material. A pound of clean seed contains 254,000 to 263,000 seed units.

### TALL OATGRASS

(*Arrhenatherum elatius*)

Tall oatgrass, a standard grass in parts of Europe, is grown quite generally in the Central and Northern States. Kalm advocated its culture in Sweden in 1747. The genus name is from the Greek word *arren*, meaning masculine, and *ather*, meaning awn, which refers to the awned staminate florets. It was cultivated in Massachusetts as early as 1807 and in South Carolina in 1821.

A hardy and upright perennial, tall oatgrass grows to 30 to 60 inches and produces many leaves. It does not propagate by rootstocks. It tends to be bunchy. It produces seed in open heads



Tall oatgrass

or panicles resembling those of cultivated oats, although the seed is smaller and much more chaffy.

Tall oatgrass prefers well-drained soil and seems to be especially adapted to light sandy or gravelly land. It does not grow well in shade. It has never attained great importance in any locality, but it does have many desirable forage qualities. It can be used for

pasture or meadow; it gives a heavy yield of hay, which is quite palatable. Although it does not produce a very good sod, it seems to stand pasturing well and furnishes abundant grazing.

It comes on early in the spring and remains green until late in the autumn. Best results are obtained if it is grazed in rotation and given controlled grazing. Under continuous, close grazing the stand is easily reduced. It is becoming a common practice in the Pacific Northwest to use a mixture of tall oatgrass and sweetclover for a short-rotation hay or pasture combination. Mixtures of tall oatgrass, orchard-grass, and red clover have been used. For the best hay the mixture should be cut at about the time that it begins blooming.

Its poor seed habit is a drawback. It produces abundant seed, but harvesting is difficult because the seed shatters before fully mature. The seed is often of low viability. The seed weighs 10 to 16 pounds a bushel. Approximately 150,000 seeds weigh a pound. The usual rate of seeding is 30 to 40 pounds to the acre.

In sections where there is a reasonable amount of moisture in autumn or late summer and where winters are not severe, best results will probably be obtained by seeding in September or early October; otherwise, spring seedings are best. Broadcasting is best, because the coarse, fluffy seed does not feed evenly through a drill. A well-fitted seedbed is essential. After sowing, the seed should be covered by cultipacking or harrowing lightly.

An improved strain, developed in Oregon, is being increased under the name Tualatin. Its seed shatters less readily than that of common tall oatgrass; in the East it is somewhat shorter in growth and has narrower leaves.

### CARPETGRASS

(*Axonopus affinis*)

Carpetgrass, a native of Central America and the West Indies, was introduced into the United States before



Carpetgrass

1832. A specimen collected near New Orleans that year is still preserved.

Carpetgrass has now spread over the Coastal Plain from Virginia to Texas and inland to Arkansas. It now grows in the Tropics of both hemispheres.

A perennial creeping grass, it makes a dense sod and is distinguished by its compressed, two-edged, creeping stems, which root at each joint, and by its blunt leaf tips. The slender flower stems grow a foot high—rarely 2 feet if

the soil is fertile. Because it has no underground stems, it never has become a pest in cultivated fields.

Carpetgrass is especially adapted to sandy or sandy loam soils, particularly where the moisture is near the surface most of the year. It grows well in the low, flat woods in the Coastal Plains region. It is moisture loving, but it does poorly in swamps or where seepage is continuous. Over much of the area where it is grown, carpetgrass is probably most valuable for permanent pasture. It also has value for firebreaks in forests, lawns and turf, for use along roads, and for open areas in the pine forests. The cheapness and abundance of seed and ease of establishment make it popular in the South.

Because its sod is dense and its habit of growth is aggressive, legumes are maintained with difficulty in a cultivated pasture when carpetgrass is used. On fertile soils it makes a good growth, but generally it is not high enough in feed nutrients to furnish a balanced diet. Consequently, it is not generally recommended for the improved, high-producing pastures.

Seed is harvested mainly in Mississippi and Louisiana. Seed harvested with a combine (the general practice now), if properly handled, is usually superior in color, purity, and germination to that cut with a mower, shocked in field, and threshed later. A pound contains about 1,350,000 seeds; a bushel of seed weighs 18 to 36 pounds.

The usual rate of seeding is 5 to 10 pounds to the acre. Seed can be sown on a well-prepared seedbed or broadcast on burned-over open areas in timberland. It is spread quite easily by grazing animals and by natural re-seeding. Seeding is best done in spring, early summer, or even midsummer.

## THE GRAMA GRASSES

(*Bouteloua* species)

All species of *Bouteloua* are native to the Western Hemisphere. About 18 species occur in the United States. They are well represented throughout

the Great Plains and Western States. They are reliable producers of good forage on range and pasture land and are prized therefore in various sections.

The gramas are summer growers, and the amount of forage they produce depends upon the moisture available during the growing season. In years of extreme drought they make little or no new top growth. Most species cure naturally, however, and standing growth from previous seasons makes very satisfactory and palatable forage for most classes of livestock.

Individual spikelets are small and single-flowered, a characteristic that greatly simplifies the identification of species of *Bouteloua*.

### SIDE-OATS GRAMA

(*Bouteloua curtipendula*)

Side-oats grama is a long-lived, native grass with an exceptionally wide, natural distribution. It is most abundant in the Great Plains. It has short, scaly rhizomes; usually it makes a bunch-type growth and seldom forms a dense sod.

The flowering stalks are 2 to 3 feet tall. The leaves are about 6 inches long and nearly  $\frac{1}{4}$  inch wide. The seed head consists of a large number of spikes set on a slender, zigzag rachis about 6 to 8 inches long. The stalks of the spikes are twisted, so that the spikes all extend, like a banner, on one side of the central axis. The root system is fairly deep and well branched; thus the plants can effectively utilize all available moisture.

Side-oats grama produces an abundance of leafy forage, which is well liked by all classes of livestock. Good hay can be had if the plants are mowed at the proper stage of growth.

Ordinarily this species is seeded in mixtures with other adapted grasses. A seeding rate of 15 to 25 pounds an acre is generally recommended. The desirable rate depends upon the quality of seed and upon the other grasses, if any, used in mixture. Seed matures about midsummer. The plants reach

sufficient height to be harvested with a binder. They can be combined with ordinary small-grain equipment.

Yields of 100 pounds or more of seed an acre are not uncommon from a native stand. If plants are grown in rows and cultivated, seed yields of more than 400 pounds an acre have been obtained.

Throughout the threshing operation, the seeds tend to remain in clusters, which usually require some mechanical treatment to break them into individual units. After it is cleaned with a fanning mill, the seed should have a purity of 30 percent and a germination of 65 percent. A pound of pure seed contains about 125,000 seed clusters or about 500,000 separate seed units.

Side-oats grama is considered excellent for conservation use. It produces a good volume of leafy forage and is adapted to a wide range of soil and climatic conditions. Seedling vigor is good, and failure to obtain a satisfactory stand seldom occurs if minimum care is used in seedbed preparation and drilling.

Elreno side-oats grama, a new variety developed through plant selection, is now being grown and certified by the Kansas Agricultural Experiment Station.

#### BLUE GRAMA (*Bouteloua gracilis*)

Blue grama is a low-growing, long-lived, native perennial that grows throughout the Great Plains. The leaves are 3 to 6 inches long and less than  $\frac{1}{8}$  inch wide. The flowering stems are 12 to 18 inches tall. Each stem usually has two purplish spikes that extend at a sharp angle from the main stem.

Blue grama is found on all soil types, including alkaline soils, but is most abundant on the heavier rolling upland soils. Its capacity to resist drought permits it to occupy the drier sites throughout its range of adaptation.

Growth begins fairly late in the season and depends on how much moisture is available. The forage is relished

by all the classes of livestock. Growth ceases during long droughts but begins again upon the return of favorable moisture and temperature. Because of its wide distribution, high quality, hardiness, and growth habits, it is one of our most important range species.

Under heavy grazing, blue grama often persists in nearly pure stands after the associated grasses disappear.

Blue grama is readily established from seed. Excellent stands have been obtained by broadcast or solid-drill seedings. The usual seeding rate is 8 to 12 pounds of clean seed to the acre. For most satisfactory results, the seedbed should be well prepared and be free of weeds, but the seedlings are relatively persistent and compete with weeds and other grasses if they are not grazed until they become well established.

The seed usually matures in August. The amount of seed produced depends on whether moisture is plentiful and temperatures are cool during the period of blossoming and seed formation. Seed heads of blue grama ripen rapidly as they near maturity, and utmost care must be used to harvest the seed before the seed heads shatter. Direct combining and swathing followed by pick-up combining are the most effective methods of seed harvest. Seed yields of 100 to 180 pounds an acre have been obtained from good natural stands.

After being cleaned in a fanning mill, the seed should have a purity of at least 40 percent and a germination of 75 percent. A pound of pure seed contains about 800,000 units.

Because of its wide adaptation, ease of establishment, and economic value, blue grama is used extensively for conservation purposes. Although its erosion-control properties are effective when blue grama is seeded alone, the general practice is to make plantings with mixtures of other adapted grasses. Most revegetation seedings have been made on range land and abandoned cropland.

As a general rule, seed should be used near its point of origin. Experi-



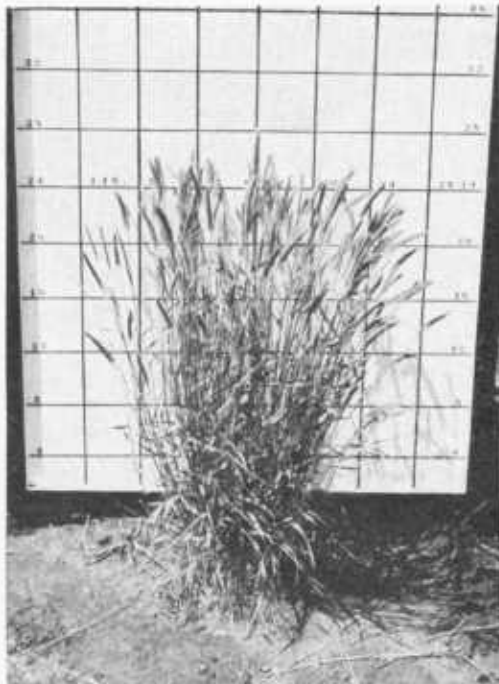
In the grass nursery at Woodward, Okla., J. R. Harlan examines strains of buffalo-grass—female plants on the right and male on the left. He compares them as to the sex ratios in different progenies, germination, seedling vigor, rate of growth, the quality and quantity of vegetation, probable seeding habits, and so on. Below, to obtain pollen, technicians at Woodward select male plants from one of the plots. Besides the new strains from plant breeders, collections from native vegetation and introductions from abroad provide material for ultimate use on farms, ranches, and eroded areas—if they survive the thorough research studies and observations.





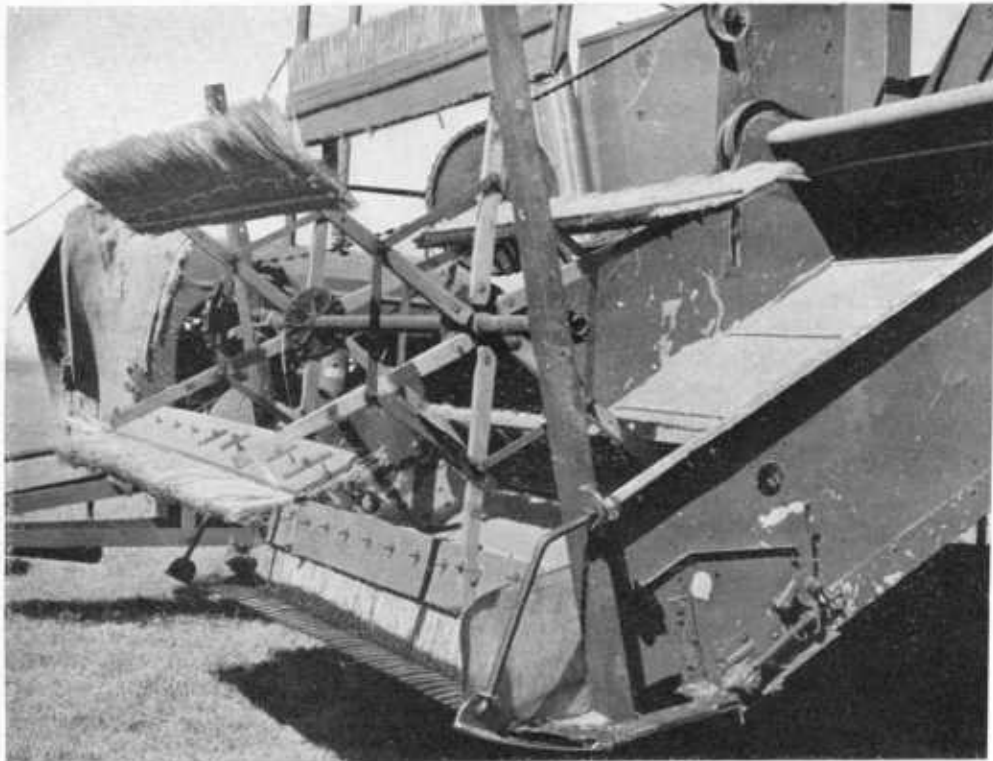
The pollen from the selected male strain is carefully brushed on the flower of a promising female plant. The resulting seed is planted, for increase, in nurseries—as in the picture below, which shows rows of Russian wild-rye at the Northern Great Plains Field Station at Mandan, N. Dak. In the nurseries, supplemental observation in conservation problem areas, and in research studies by several units of the Department, new grasses are tested at this stage for influence on the soil structure and the fertility, resistance to diseases and insects, response to acid or alkali soils, value for forage and conservation, season of use, and the rate of development.



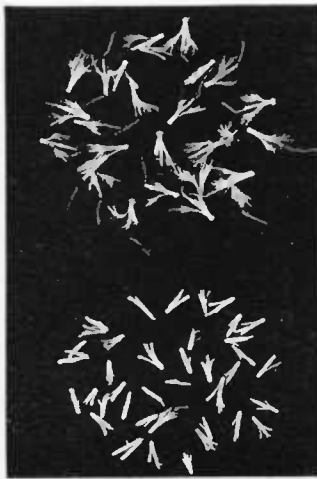


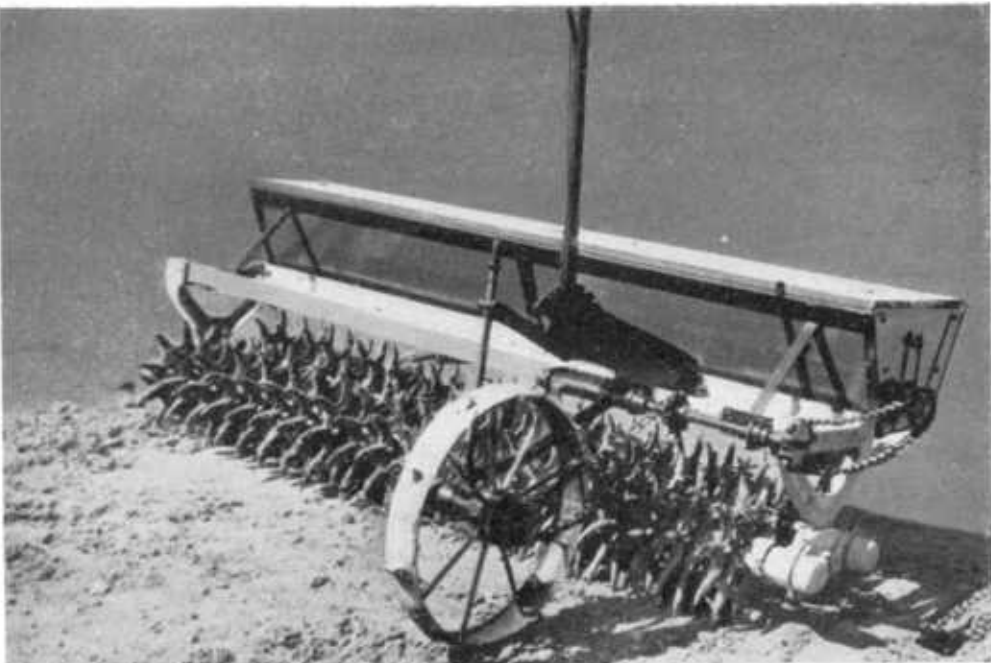
Among the many new grasses that are being developed or tested in the Great Plains nurseries are (top, left) a typical plant of the standard crested wheatgrass; (top, right) a new wheatgrass, stiffhair wheatgrass or *Agropyron trichophorum*, that is well adapted to the Plains region; (below, left) Siberian wheatgrass, which was introduced from Russia and resembles the crested wheatgrass but is inferior to it; and (below, right) Mandan wild-rye, an improved strain of the Canada wild-rye that was released to American farmers in 1946. Whatever laymen think of grass, to plant breeders a grass is a living individual with its own specific uses, habits, place, and needs.



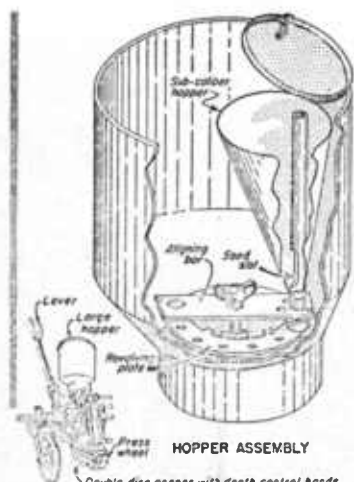


The work of getting new and better grasses and legumes is big and complex. As A. L. Hafenrichter and A. D. Stoesz put it, one has to find, assemble, test, and improve new materials and then grow large amounts of seed. Sometimes one has to devise special machines to harvest and plant the new grasses. One such is the seed harvester (above). The fluffy, chaffy seed, as harvested, is usually threshed and treated in a hammer mill. Below are pictures of unprocessed (top) and processed seed of grama, bluestem, and wild-rye. Many farmers have their own seed plots; from several hundred production fields other farmers can obtain seed.

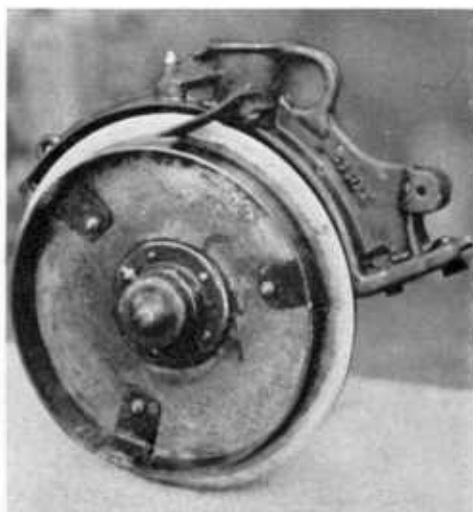




Agricultural workers have had to perfect special drills and drill attachments to make it easier to seed in stubble mulches, reseed ranges and abandoned lands, and plant the new grass-legume mixtures. A rotary hoe (above) and a double drill box were combined so that mixtures of a large-seeded grass, a small-seeded grass, and a legume could be planted in stubble mulches. Drill box attachments were made to handle tiny seeds (below, left) like those of lovegrass. Depth hands were fastened to double-disk drills (below, right) to plant the seeds uniformly at shallow depth. Sometimes grass grows like Topsy; sometimes it needs special techniques.



SMALL SEED ATTACHMENT FOR DRILL





Fertilization is a major item in grassland agriculture. A test plot of wild-rye at Mandan got no fertilizer; on another acre (below) 90 pounds of nitrogen was used. Soil fertility regulates the amount of crop growth and influences its quality. As J. T. Sullivan and H. L. Wilkins point out, fertilization may favor the growth of some plants rather than others. Fertilizers also change the chemical composition of the individual plant. Plants take up any element present in soluble form in the soil and may take up more when more is present. The response to fertilizers depends upon the fertility of the soil and upon the age and condition of the plant.





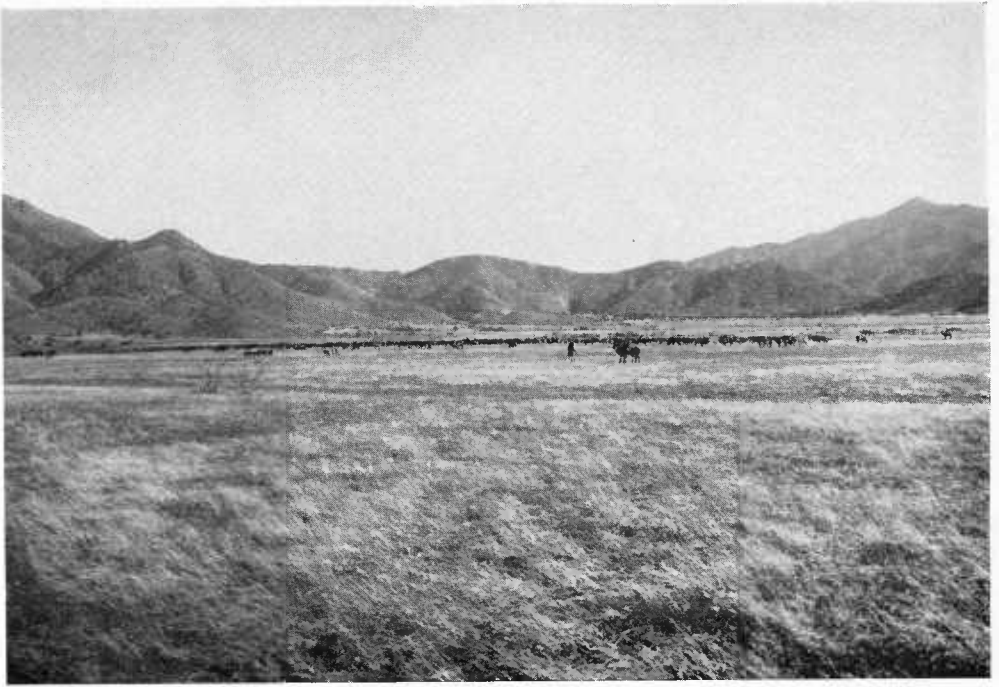
Sand dunes in the United States cover an area a tenth as large as the area of farm land. Along the coasts, around the Great Lakes, and in nearly all inland States, dunes menace forests, destroy agricultural lands, and leave waste behind. In the words of Charles J. Whitfield and Robert L. Brown, sand dunes have been a problem for centuries; most of the active dunes in the United States are caused by man's abuse of the protective cover of vegetation; their permanent control can be achieved only by establishing on them a vegetative cover by natural succession or by seeding. Mechanical structures stop sand movement only temporarily.



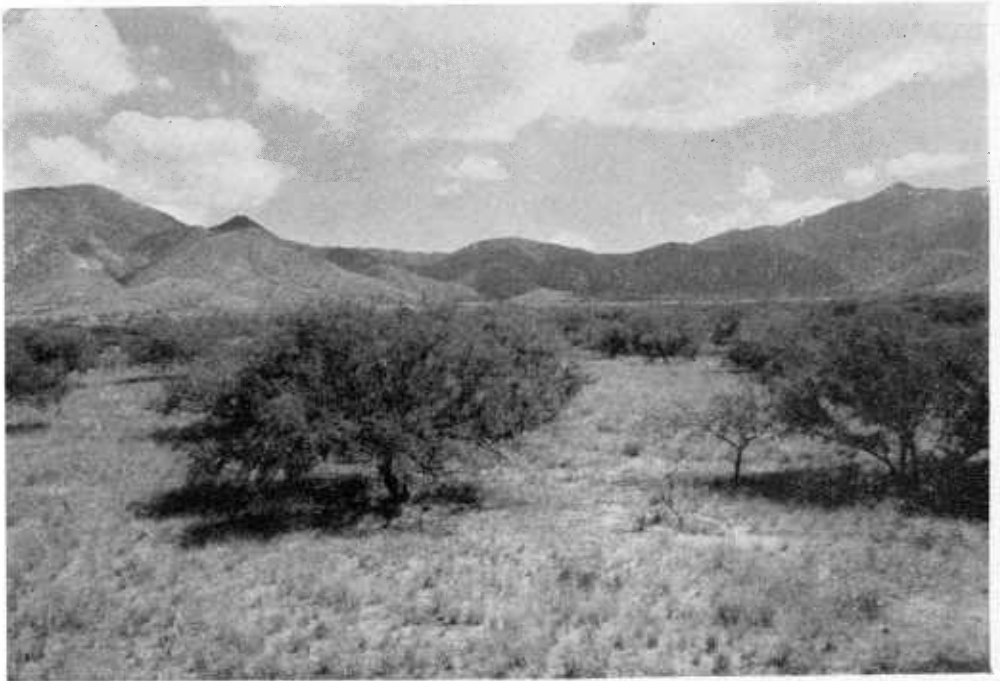


A coastal dune in Oregon (preceding page, top) was out of hand. First, to stabilize it, the sand was stilled temporarily with beachgrass (preceding page, bottom; and above). A year later (below), the dune is permanently fixed by the perennial plants like Clatsop red fescue, tall fescue, hairy vetch, and purple beachpea. In the Midwest and Great Plains the hard areas around individual dunes are often deep-listed to catch sand blown from the dunes and scatter it; sometimes a drag pole is used to break down the crests. The area is then mulched and seeded to switchgrass, the bluestems, Indiangrass, big sandreed grass, the lovegrasses, or others.





The picture above was taken in 1903. It shows an open, productive grassland in the Southwest, the kind that made the pioneers stop and marvel at the bounty of nature, at the luxuriant grass that grew belly-high to a horse and fed cattle like no other. Forty years later the picture below was made from the same spot. What has happened here has happened on millions of acres in Arizona, Texas, and New Mexico: Mesquite, a low-value forage plant, has invaded the range after grazing by domestic livestock—and grazing capacity is lowered, erosion is accelerated, the costs of handling livestock are up. The remedy: Kill the noxious plants, reseed, then graze conservatively.





A burned brush range in central Utah supported mainly big sagebrush, snowberry, shrub oak, and chokecherry. Seed of 17 promising species of range plants was broadcast and harrowed in (above). In September of the following year grass nearly waist-high (below) was growing on the place, and the grazing capacity was 15 times greater than before burning. Men in the Forest Service estimate that 80 million acres of range land need reseeding. To be successful and as inexpensive as possible, reseeding must be done carefully: Sites must be chosen wisely; low-value competing vegetation must be removed; and proved species seeded according to tested practices.





At Woodward, Okla., mowing in two successive Junes and keeping livestock off the range from June to September killed many sagebrush plants, weakened the rest, improved the pastures, and made surviving shrubs more palatable. Almost any heavy-duty power take-off mower, properly equipped, can be used to mow heavy brush (above). Tests in 1947 near Woodward and in Texas showed that 2,4-D, which can be applied from airplanes for as little as \$2 an acre, killed sand sagebrush, skunkbush, plum thicket, and many other range weeds. Below, E. H. McIlvain, ecologist at the Southern Great Plains Field Station at Woodward, inspects results of the mowing and the weed killer.





Many types of implements have been used to control noxious plants. A specially designed bit (above) is used to uproot a late species of juniper, or cedar, on thousands of acres in Texas. A one-way disk plow, of the wheatland type, is commonly used for eradicating sagebrush in Utah, Idaho, and Nevada (below). Other tools used with varying success in the Southern Great Plains to remove brush include brush beaters, which do a good job if properly built; rolling cutters, which are satisfactory in brush too heavy to handle otherwise; and railroad rails. To fight mesquite, sodium arsenite, oils, grubbing, or power machinery are recommended.





Of many ways to put up hay, no one method seems best for all farms. As R. B. Gray says, kind and quantity of hay, its use, growing conditions, equipment, and so on determine the choice. But regardless of method, the grass must first be cut—by the familiar mower or a newer machine. The field grass chopper (above) cuts and chops the green crop for silage as it stands in the field. Or, after cutting, the hay is raked into windrows to facilitate handling. Dump rakes handle widths up to 24 feet. Below is a tractor-powered side-delivery rake on rubber, designed for fast raking and raking heavy crops. Its four-bar reels are said to shatter the leaves less.





After the hay is cut and windrowed, it is loaded or baled. The raker-bar loader (above) has reciprocating bars with flexible teeth that rake the hay up the sloping deck and drop it on the rack. It has a folding foretruck for easier storing. For loading green crops, loaders built more ruggedly are often used. Of several types of balers, a one-man baler (below) makes a roll 36 inches long, 14-22 inches thick, and 40-100 pounds in weight. Its pick-up feeds the hay into a series of belts. When the desired diameter of bale is attained, a device ties it with twine. Other types of balers are operated by one, two, or three men and use wire or twine. Some make rectangular bales.



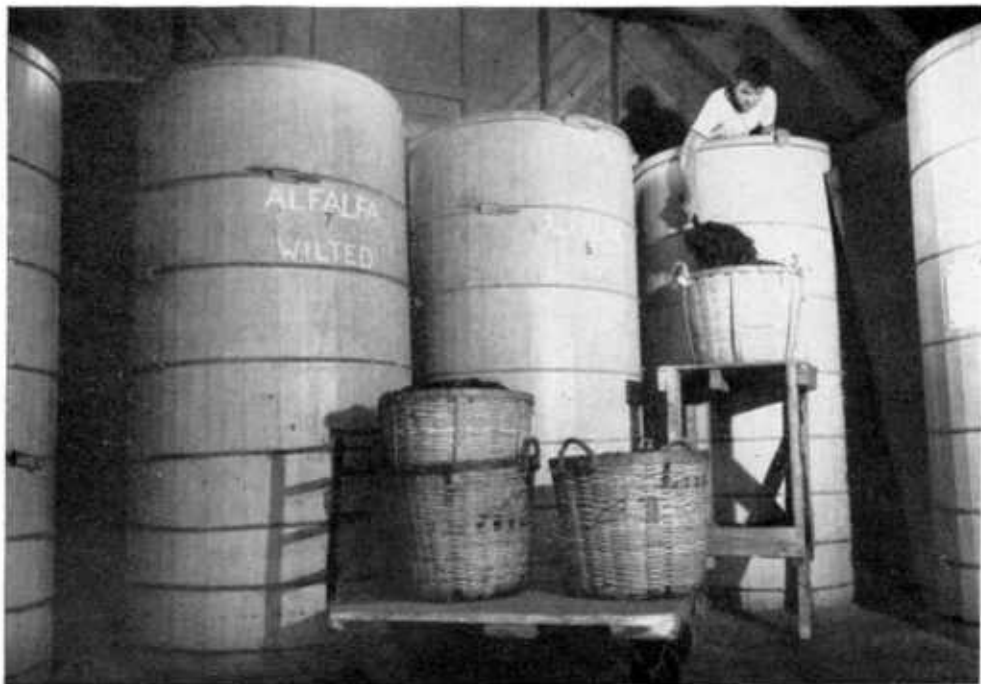


A mower-crusher (above) is available to make it easier to cure coarse-stemmed hay. It cuts the hay in the usual way and passes it through crushing rolls to crack the stems. Then the hay is windrowed. On the Group Brothers farm in south-eastern Pennsylvania (below), field-chopped grass is unloaded from a truck into the trough of the elevator that blows the material into the silo. The motor at the right operates a shaft that rolls back a canvas floor in the truck to speed up unloading. The Group Brothers use a 4-1-1-1 rotation of grass-legumes, corn, oats, barley. Two-thirds of their farm is in grassland, primarily orchardgrass and Ladino.





To see whether his legume hay is ready for ensiling, a Pennsylvania farmer uses a moisture tester (above), a flat-bottomed plunger in a steel pipe. A hay sample in the pipe is too wet if juice oozes from small holes in the pipe when 32 pounds of sand is put in the pail. If no juice comes when twice that weight is applied, the hay is too dry. Scientists in the Bureau of Dairy Industry, who devised the tester, set up baby silos (below) at Beltsville to help in their extensive tests of silage mixtures and treatments. Later in full-size silos they conduct further experiments with processes that look promising in the pilot silos, which measure 4 feet by 8 feet.





Blue grama

mental plantings of North Dakota seed have not been productive when planted in the Southern Great Plains and, conversely, plants from Texas-grown seed do not make satisfactory growth in North Dakota. This matter of plant adaptation is important with many of the native grasses and has led to the general caution that locally grown seed should be used whenever it is possible to do so.

## THE BROME GRASSES

(*Bromus* species)

Grasses of the brome genus are found mostly in the North Temperate Zone. About 43 species are native to the United States. Some of our most important forage species belong to this genus—and also some of our most troublesome weeds.

The name is derived from *bromos*, an ancient Greek name for a kind of oat, and is cognate with *broma*, food. Most bromes are highly palatable—even the weedy bromes, during their period of most active growth.

Leaf blades of the bromes are characteristically flat, and the edges of the sheath grow together to form a tube. The seed heads are usually more or less open and spreading, forming panicles. The tip of the rather rigid lemma is notched into two teeth, between which the awn arises.

### CALIFORNIA BROME

(*Bromus carinatus*)

The California brome is a vigorous, short-lived native of the Rocky Mountain and Pacific coast regions. Many botanists consider it a polymorphous species that includes *Bromus marginatus*, *B. maritimus*, and *B. polyanthus*. All forms are closely related, and separations among them can be made only arbitrarily.

Plants grow 3 to 4 feet tall. Leaf blades are flat, 6 to 8 inches long, and about 1/2 inch wide. The seed is rather strongly awned.

The species is characterized by ca-

capacity to produce large quantities of leafy forage that is relished by all classes of livestock. The mature foliage is harsh and less palatable, a condition that is offset somewhat by the fact that the seed heads are palatable and nutritious.

This species would have extensive use for revegetation if adequate seed supplies were available. Some progress has been made in developing commercial supplies of the seed.

### RESCUEGRASS

(*Bromus catharticus*)

Rescuegrass, a native of Argentina, was introduced into the Southern States about 100 years ago and now appears spontaneously in many places there. It is a short-lived perennial adapted to humid regions with mild winters.

Plants grow to a height of 2 to 3 feet. Leaf blades are 8 to 12 inches long and about 1/4 inch wide. Young plants are usually pubescent, but mature plants are only slightly so. Panicles are branched and are about 6 inches long, with two to five spikelets at the extremity of each branch.

Growth starts in the fall and continues through the winter; the plants mature in early summer. On poor land they make little growth but on rich soils they produce a good amount of forage, which is relished by livestock. The growing vegetation also protects the soil against erosion in winter.

Seed is produced abundantly, and is usually available commercially.

Rescuegrass can be seeded readily with available farm equipment.

### SMOOTH BROME

(*Bromus inermis*)

Smooth brome is a long-lived, perennial sod grass with strong creeping rhizomes. It is native to Europe, Siberia, and China. It was introduced into the United States in 1884 and has been grown widely throughout this country. It is adapted especially to



Smooth brome

regions of moderate rainfall and low to moderate summer temperatures.

Plants grow to a height of 3 to 4 feet and produce an abundance of basal and stem leaves. Leaf blades vary from 8 to 12 inches in length and from  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in width. The leaf sheaths are smooth and closed, forming a tube. The inflorescence is a panicle from 6 to 8 inches long. The root system is extensive, with strong rootstocks. The interlaced roots and rootstocks form a coarse but dense sod, which resists grazing and trampling and, by binding the soil, protects it against wind and water erosion.

Two distinct types of smooth brome, differing in growth behavior, are generally recognized.

The "southern type" came originally from central Europe and is best adapted to the Corn Belt States and to the parts of the central Great Plains that have protracted dry periods and high summer temperatures. Improved varieties include Achenbach, Lincoln, and Fischer.

The "northern type" was introduced from Siberia and has been found well adapted to Canada and the Northern Great Plains, where long periods of hot weather seldom occur.

Smooth brome makes its best growth on moist, well-drained clay loam soils of relatively high fertility. Although more drought-hardy than most cultivated species, it does not withstand the extremes of low moisture and low winter temperatures so well as crested wheatgrass or many of the native grasses of the Great Plains.

As a pasture or hay grass, smooth brome scarcely has an equal in the area of its best adaptation. Growth begins early in the spring and continues through the summer if enough moisture is available. Its good volume of leafy forage is relished by all classes of livestock.

Satisfactory stands have been obtained in the Great Plains, where this grass has been seeded at rates of 12 to 15 pounds an acre on well-prepared, weed-free seedbeds. Smooth brome fits

well into a grass-legume seeding, and many acres are now in brome-alfalfa mixture that formerly were devoted to legumes alone.

Such grass-legume seedings have special conservation and economic values. They give greater forage yield and protection to the soil than either the brome or the alfalfa would have given if seeded alone, and the danger of bloat to grazing animals is less. The presence of a legume in the mixture also prolongs the useful life of the stand, presumably because it increases the amount of nitrogen available in the soil and thereby keeps the grass stand from becoming sod-bound.

Seed matures in midsummer. Under normal conditions about 75 percent of the seeds are well filled. Yields often average 300 to 500 pounds of seed an acre—more, if the grass is grown in rows on fertile soil and cultivated.

Seed may be harvested with a binder or with a small-grain combine. Combine- or thresher-run seed, if cleaned with a fanning mill, should have a purity of 85 percent and a germination of 90 percent. Approximately 175,000 pure seeds weigh a pound.

#### MOUNTAIN BROME (*Bromus marginatus*)

Mountain brome is a short-lived grass that is native to the Rocky Mountain and Pacific coast regions. It is closely related to California brome and similar to it in soil and climatic adaptation.

Plants usually grow to a height of 3 to 4 feet, with leaves 6 to 12 inches long, and about  $\frac{1}{4}$  inch wide. The flat leaf blades are usually hairy on their lower parts. Leaf sheaths are closed and form tubes.

Growth starts in early spring and continues with the production of large amounts of leafy forage that is liked by livestock. Rapid growth, vigor of seedlings, and a well-branched and deeply penetrating root system, the outstanding characteristics of mountain brome, make it one of the most

valuable grasses for use where vegetative cover is required immediately to protect erodible sloping land.

Seed matures in midsummer and can be harvested with a binder or with a small-grain combine. Good-quality seed can be obtained by cleaning the combine-run seed material with a fanning mill. Seed yields are heavy and the quality and the amount produced from cultivated rows are significantly greater than from solid seedings. Seed yields of 400 to 500 pounds an acre have sometimes been obtained where the grass is grown primarily for seed. The forage remaining after removal of the seed crop is of fair quality and may be grazed or cut and cured for roughage.

One of the important uses of this grass in the agriculture of the Pacific Northwest is for seeding in mixture with alfalfa or sweetclover. In such a mixture, the grass adds materially to both root and top growth. The combination offers greater soil protection than legumes alone because of greater density of plants and greater volume of roots. It is said also that the mixture of grass with the legumes, which are high in protein content, lessens the danger of bloat and provides a better-balanced forage.

Bromar, an improved variety, has recently been released by State experiment stations of the Pacific Northwest and is being produced as certified seed in commercial quantities by members of the several crop-improvement associations.

### BUFFALOGRASS

(*Buchloë dactyloides*)

Buffalograss is a fine-leaved, native, sod-forming perennial. It is the dominant species on large areas of upland on the short-grass region of the central part of the Great Plains. Generally it grows 4 to 6 inches high and produces leaves less than  $\frac{1}{8}$  inch wide and 3 to 6 inches long. It spreads rapidly by surface runners and forms a dense, matted turf. During the growing season



Buffalograss

the foliage is grayish green, which turns to a light straw color when the plants cease growth.

Growth begins in late spring and continues through the summer. Livestock like its forage. Its palatability, prevalence, and adaptation to a wide range of soil and climatic conditions make it an important forage species of the Great Plains.

It withstands long, heavy grazing better than any other grass native to that region; on ranges consistently subjected to severe use it often survives as a nearly pure stand. Because of its excellent ground cover, aggressive spread under use, wide climatic adaptation, and relative ease of establishment, buffalograss is ideally suited for erosion control on range and pasture lands where the soil does not contain too much sand.

The seed of the grass is enclosed in hard burs, one or more grains in a bur. The burs normally have a low germination. Soaking and chilling, processing with a hammer mill, or some other

such treatment of the burs is usually required to insure good stands from planting at moderate rates.

Small-grain combines altered so that the sickle can be run very close to the ground are satisfactory for harvesting buffalograss burs from ungrazed stands. Suction machines, brooms, or beater equipment must be used to collect seed from closely grazed stands.

Natural stands have yielded as much as 100 pounds of clean burs to the acre. A pound averages 40,000 to 55,000 clean burs.

The buffalograss plants are unisexual; about half are female in function and produce seed burs; the others are male in function and produce pollen only. When plants are grown under cultivation primarily for seed production, it is customary to grow 10 seed-producing plants to 1 pollen plant. This proportion of female to male plants greatly increases the amount of seed produced under cultivation on a given acreage over that possible under natural conditions.

Revegetation by use of sod pieces is effective. Sod pieces about 4 inches in diameter are placed at 3- to 4-foot intervals on a well-conditioned seed-bed. Usually this results in a complete sod cover by the end of the second growing season.

Buffalograss seed is available from commercial sources, although not in abundance.

## RHODESGRASS

(*Chloris gayana*)

Rhodesgrass was first brought to the attention of the agricultural world by the late Cecil Rhodes, after whom it is named. It is a perennial grass native to South Africa and was first introduced into this country in 1902.

It is fine-stemmed and very leafy and grows approximately 3 feet high. The spreading, clustered spikes of the flowering head number from 10 to 15, and seed is produced in abundance. The plant also spreads by running branches, or stolons, that are 2 to 6



Rhodesgrass

feet long and root and produce a plant at every node. That factor suggests that the Rhodesgrass might become a troublesome weed, but such has not been the case. Tests show that it can be easily controlled.

Rhodesgrass is not winter-hardy and rarely withstands temperatures below 15° or 18° F. Its adaptation therefore is limited. However, it is winter-hardy and perennates in a narrow strip along the Gulf Coast from Florida to southern Texas and in southern Arizona and California. Farther north it must be treated as an annual, but as yet its use in that way is not recommended.

It does best on fairly moist soil, although it will make growth during several months of drought. It grows well on sandy soils in southern Texas, well-drained peaty soils in Florida, and on soils too alkaline for alfalfa, cotton, and other crops in southern California.

Rhodesgrass can be sown any time during warm weather, but early spring usually is preferred. The seed is usually broadcast at rates of 5 to 7 pounds per acre. In regions of abundant rainfall or

in irrigation fields, rates of 10 to 12 pounds may be advisable. The quantity also varies with quality of the seed and condition of the land. A well-prepared seedbed will help insure a good stand, although stands have been established on rather loose, rough ground.

Rhodesgrass was first cultivated for pasture. It withstands trampling, recovers quickly, and is relished by livestock. Rotation grazing is the best method of management to insure greater production and maintenance of stand. It will also yield a leafy hay of high quality. The production for pasture or hay varies greatly, depending on soil fertility and the season. Yields of 5 to 7 tons of hay an acre have been reported.

Rhodesgrass will produce three or four crops of seed a year, but the seed development lacks uniformity. The first crop is generally the most productive, with annual yields of 400 to 500 pounds an acre not uncommon. Seed is harvested with combine, binder, or, sometimes, with seed strippers. Because of lack of uniformity in maturity, great care is necessary to obtain seed of good quality. The seeds vary greatly in size but average approximately 2 million to the pound.

### BERMUDA-GRASS

(*Cynodon dactylon*)

Bermuda-grass is a native of the Old World, probably of India, but is now common in all tropical and subtropical parts of the world. We do not know when it was introduced into the United States, but reports published in 1807 mentioned it as an important grass in the Southern States. Now it is found in all parts of the southern half of the United States from Virginia to Florida and westward to Arizona and California. It is also called wiregrass, dog's tooth grass, and devil grass.

Bermuda-grass is a long-lived perennial with a spreading habit of growth. It propagates by runners, underground rootstocks, and seed. The runners vary from a few inches to 3 or 4 feet in

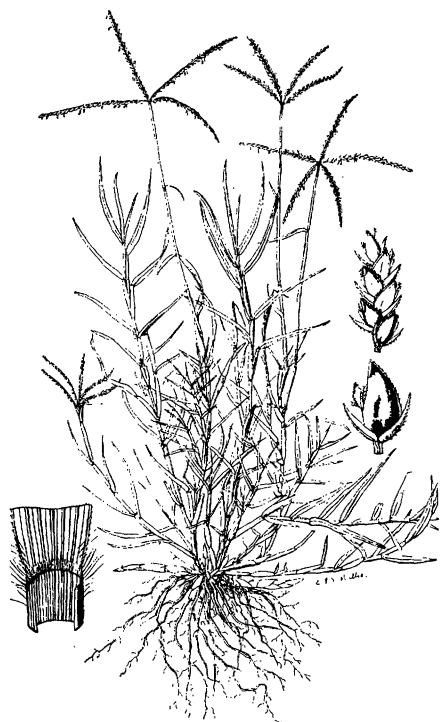
length, and under favorable conditions they may grow 15 to 20 feet in a season. The rootstocks, which may become stolons (runners) on hard soils, are thick and white. The erect, flowering branches are usually 6 to 12 inches high, depending on the fertility and moisture of the soil. The leaves are short, flat, bluish-green, and 1 to 4 inches long. At the base of each leaf is a fringe of white hairs; the leaf sheath is compressed and slightly hairy. The flowers are in slender spikes, three to six in a cluster, similar in appearance to crabgrass.

Bermuda-grass will grow well on almost any soil that is fertile and not too wet but better on heavy soils rather than those that are light and sandy. It thrives in warm or hot weather. It usually does not survive heavy freezes, although it has lived through temperatures of 10° F. in the vicinity of the District of Columbia. For that reason it is often considered as a weedy pest in the lawns in parts of Virginia and Maryland.

Bermuda-grass may be propagated by seed or by vegetative cuttings or stolons. Because the seeds are small and light, a well-prepared seedbed is desirable for best establishment. Spring seedings, 5 to 7 pounds to the acre, are generally best. The seed should be covered with a cultipacker or a light harrow.

Many methods are used in planting stolons. The common practice is to plow furrows 4 to 6 feet apart, drop stolons 2 or 3 feet apart in the furrow, and cover them by plowing or with the foot. Deep planting is important if the stolons are not watered when set, because the stolons might dry out. Rolling or cultipacking the soil after plantings is also desirable. A complete fertilizer, such as 4-8-4 or 6-6-6, should be applied at 400 to 600 pounds per acre just ahead of planting or seeding. For rapid establishment, nitrogen fertilizer should be applied in midsummer at rates of 100 to 200 pounds of nitrate of soda or its equivalent.

The principal use of Bermuda-grass



**Bermuda-grass**

is for pasture and lawns, but it is also used for hay. It is palatable and nutritious even after frost in the fall. Many farmers hesitate to use it because it is difficult to control in row or cultivated crops.

Bermuda-grass responds to cultivation and old undisturbed pasture sods soon become weedy and unproductive. The best method of maintaining a productive pasture with it is by shallow plowing every 3 to 5 years or so, fertilizing, and maintaining the stands of legumes in it.

Improved varieties are more vigorous in growth than common Bermuda, more disease-resistant, and superior in other characters. These new varieties produce seed sparsely and must be planted vegetatively. Of the two varieties most widely used now, Coastal Bermuda is more productive over the region than Suwannee, but Suwannee shows promise in Florida. Fine-leaved, compact, sod-forming strains also are

now being developed for lawn and turf purposes, but are not ready yet for distribution.

Commercial seed supplies of common Bermuda-grass are harvested in Arizona and southern California. Seed is harvested from volunteer stands of grass in old abandoned cultivated crop fields and alfalfa plantings. Seed yields vary from 100 to 200 pounds an acre. One or two seed crops are harvested annually with an ordinary field mower and then threshed soon after harvest.

Insects and disease have caused some injury. In Florida mole crickets have been known to kill out large areas; a scale insect is widely distributed, but it has not caused serious damage. Diseases that attack Bermuda-grass are *Rhizoctonia*, *Helminthosporium*, and *Sclerotium*.

## ORCHARDGRASS

(*Dactylis glomerata*)

Orchardgrass has been in cultivation in North America since 1760. It is a native of Europe, where it is known as cocksfoot. It is a long-lived perennial, a distinctly bunch-type grass with folded leaf blades and compressed sheaths. It grows in large contiguous masses. This tussock-forming habit is lessened somewhat by careful grazing management and by seeding with a legume, such as Ladino clover, lespedeza, or alfalfa. It does not produce stolons or underground rhizomes and, therefore, never forms a dense sod. The peculiar cluster formation of the inflorescence is characteristic and cannot be mistaken for that of any other cultivated grass.

Orchardgrass was first cultivated in Virginia. Now it is widely distributed over the United States. Its persistency, leafiness, and ability to withstand relatively adverse soil and climatic conditions in the humid temperate regions of the United States make it a desirable pasture grass. The most extensive acreage is in the southern half of the timothy-bluegrass region, which extends from southern New York State to

southern Virginia and westward from the Atlantic coast to eastern Kansas and southeastern Nebraska.

Orchardgrass flourishes on rich soil, but it also succeeds on light soil of medium fertility and on moist, heavy land. Sometimes it does well where Kentucky bluegrass is unsuccessful. It is one of the best cultivated grasses for shade. Where it is adapted it is generally dominant in orchards, woodland pastures, and similar areas. It is quite cold-resistant and continues growth until the first severe frosts. Orchardgrass is more productive and better adapted in the southern range of the timothy-growing region than timothy or smooth brome because it will tolerate more heat, drought, and lower soil fertility. It can be seeded in early spring with or without a nurse crop. It is one of the first grasses to start growth in the spring. Smooth brome and timothy are more resistant to winterkilling, but neither can equal orchardgrass in summer production of leafy pasturage.

Livestock graze orchardgrass early in the spring, and since it starts growth early it is necessary that the animals be turned on before seed heads form; otherwise the early spring growth becomes unpalatable for pasturage.

Good results have been obtained with a combination of orchardgrass and Korean lespedeza in regions where lespedeza is adapted. Both the grass and the legume thrive on soils of medium fertility although both, of course, respond to improved fertilizing practices. The bunch type of growth, once considered objectionable, makes orchardgrass an ideal companion for Korean lespedeza. Both thrive in summer and therefore extend the pasture season on land that would not maintain a growth of clover or alfalfa.

The practice of making grass silage has further demonstrated the value and usefulness of orchardgrass. When it is grown in combination with legumes such as red clover and Ladino clover, orchardgrass is able to produce the maximum tonnage of high-quality



Orchardgrass

silage early in the season. If this early growth is removed, the orchardgrass will not crowd the legume, and its rapid recovery will produce an abundant, high-quality summer pasturage at a time when permanent pastures are dormant. This production during the summer months, when permanent pastures are unproductive, is an important factor in favor of this grass. Although other grass-legume combinations may

give equal or higher total forage yields for the season, orchardgrass has a definite place in pasture management because livestock must have continuous pasture of good production throughout the growing season.

Grown alone, orchardgrass will average 1 to 2 tons of field-cured hay to the acre. From a combination of orchardgrass and clover or alfalfa, yields of 2 to 3 tons can be expected. In the seed-producing areas of Kentucky and Virginia, the growth remaining after seed harvest is used to good advantage for pasture or hay.

In Virginia the northern counties produce most of the seed. In Kentucky the central section and Oldham and Henry Counties in the north are among the high seed producers.

A common practice for establishment of orchardgrass for seed production is to sow 1 bushel (about 14 pounds) with red clover and take a hay crop the first year. Seed is harvested in succeeding years and the aftermath pastured or removed as hay. Some growers successfully use sweet-clover or alfalfa in combination with orchardgrass. Yields of 350 pounds of seed per acre have been reported from orchardgrass in 3-year-old stands with alfalfa; afterward, 1 ton of high-quality hay was obtained per acre.

Nitrogen is probably the most effective fertilizer in increasing seed yields and quality. On soils of medium to good fertility, nitrogen appears to give the most effective results. Approximately 20 to 30 pounds of nitrogen are usually sufficient, except on poorer soils or on old established fields of orchardgrass in which 40 to 50 pounds of nitrogen may be necessary. Heavier applications often cause the grass to lodge and sometimes cause the heads to fail to fill out.

Orchardgrass is not seriously troubled by insect pests. Diseases have been less severe in grazed fields than when the grass is allowed to grow to hay stage. The most serious diseases are anthracnose, leaf stripe, leaf blotch, and stripe smut.

It is estimated that about 1 million acres of orchardgrass are grown each year; 40,000 acres or more are harvested for seed. The harvesting season is usually in June. A small quantity of seed is occasionally imported, but most of the seed used in this country is grown here.

### WILD-RYE (*Elymus* species)

The genus *Elymus* is well represented in the native grass species of the Western States. Most wild-rye species are perennial and many are bunchgrasses; a few, however, form sod.

The scientific name is derived from the Greek *elumos*, an ancient name for a kind of grain.

These grasses have coarse and rough foliage and are relatively unpalatable, but they are most useful for revegetation because of their good seed habits, high forage production, wide adaptation to a variety of soils, and relative ease of establishment.

The wild-rye grasses are susceptible to ergot, a fungus disease that replaces the kernel of the seed head. If livestock eat large quantities of ergot, losses may be serious.

### CANADA WILD-RYE (*Elymus canadensis*)

Canada wild-rye is a vigorous, widely distributed, perennial bunchgrass. It is most abundant in the Great Plains, the Pacific Northwest, and the Rocky Mountain States.

The seed heads grow to 3 to 5 feet and may be green or green-blue. The leaf blades are broad, flat, and rough. They are 6 to 12 inches long and usually  $\frac{1}{2}$  inch or more wide. The mature spikes, dark purple in color, average nearly 6 inches in length and have sharp awns that emerge from the spikelet parts.

Wild-rye begins growth about a week later in the spring than brome or crested wheatgrass. It usually continues to grow through the summer if



Canada wild-rye

moisture conditions are favorable, and may resume growth in the fall after a summer drought if enough moisture is available then.

The palatability of the forage is fair but becomes less as the plants become harsh and woody at maturity. The young seedlings are exceptionally vigorous and quickly form a good protective cover; Canada wild-rye therefore is useful in mixtures, especially with grasses that do not produce ground cover rapidly.

Seeding rates should vary with the number and kinds of other grasses in the mixture. Ordinarily 6 to 8 pounds of Canada wild-rye to the acre produces a good stand.

Hay of good quality may be had if the wild-rye is harvested just as the seed heads are emerging from the boot.

Seed matures in late summer and can be harvested most satisfactorily with a binder. Seed may also be harvested directly with a small-grain combine, but if this is done, the product is likely to include an excessive quantity of immature seed, which lowers germination and the general vigor of the seedlings.

Seed yields of 300 to 400 pounds an acre have been obtained from natural stands; yields from grass grown in rows and cultivated are higher.

The combine- or thresher-run seed should have an average purity of 65 percent and a germination of 90 percent. Processed pure seed contains 110,000 to 120,000 seeds to the pound.

The awns present on Canada wild-rye seed make seeding with ordinary farm drills difficult. The awns, like the seed appendages on many other species of native grass seed, can be removed readily by processing the seed with a hammer mill. The additional time and effort required for processing and seed cleaning is more than offset by the improved quality of the seed.

Mandan wild-rye, an improved variety developed through selection and breeding at the Northern Great Plains Field Station in North Dakota, produces more forage and seed. Its seed is

now being produced under certification by members of the North Dakota Crop Improvement Association.

### GIANT WILD-RYE (*Elymus condensatus*)

Giant wild-rye is a coarse, robust, perennial with thick, short rootstocks. It occurs in all the Western States. It is the largest of the native ryegrasses. Individual plants often grow 10 feet high and form clumps several feet thick. The erect flower spikes may grow 1 foot long. Leaves are flat and coarse, nearly  $\frac{3}{4}$  inch wide and 2 feet long. The extensive root system has short, thick, perennial rootstocks.

This bunchgrass is abundant on moist or wet saline soils; it occurs also on moderately dry fertile soils, but moderate grazing, especially during early spring, is essential to good stands.

During the early settlement of the Western States, it was a primary source of spring grazing and winter feed for livestock. Excessive use, particularly while the plants were young and succulent, has depleted the natural stands.

Giant wild-rye is grazed readily while young. Later the foliage becomes coarse and harsh, and livestock leave it if they can get more palatable forage. If it is left standing, the grass provides a considerable amount of winter feed for cattle and horses. Fairly good hay can be had from the young growth.

Good stands of giant wild-rye have been obtained by drilling the seed about an inch deep. It is valuable for range reseeding on flood plains. Seed of native stands can be harvested by combine.

Scarcity of seed has limited the use of giant wild-rye for revegetation of range lands in the West.

### BLUE WILD-RYE (*Elymus glaucus*)

Blue wild-rye is a native perennial bunchgrass that grows throughout the Western States, particularly on old burns and cut-over areas in the North-



Blue wild-rye

west. It commonly grows in small tufts and rarely forms dense, pure stands. It is the most widely distributed and common species of wild-rye in the Western States.

Seedstalks may grow to 5 feet high, with broad, flat, smooth leaves nearly 12 inches long. Roots are vigorous and penetrate deeply. The plant derives its name from the bluish bloom on leaves and stems.

It is most abundant on moist soils, but it stands considerable drought. The foliage, although rather coarse, is grazed by cattle and horses, especially during the early part of the season, when they seem to relish it.

Blue wild-rye produces good growth during the cool season in parts of California; it also persists very well there under limited rainfall and shows promise for use as dry-land pasture, hay, or range.

Experimental plantings as a vegetative cover in wood lots in Washington have been successful; black locust trees

made optimum growth in plantings with various grasses and legumes as ground cover. Blue wild-rye was shade-tolerant, provided excellent ground protection, and gave the highest forage yields of the several grasses under test. When planted with alfalfa under these conditions, the forage yield of alfalfa-grass was good, but the grass-legume mixture seeding depressed tree growth.

When grown under cultivation, seed yields of 300 to 400 pounds an acre have been obtained. The threshed seed had a purity of 80 percent as it came from the thresher; when it was cleaned, its purity was 97 percent and the germination was 81 percent. The test weight is about 23 pounds per bushel.

Blue wild-rye has not been used extensively in reseeding, primarily because of inadequate seed supplies.

## THE LOVEGRASSES

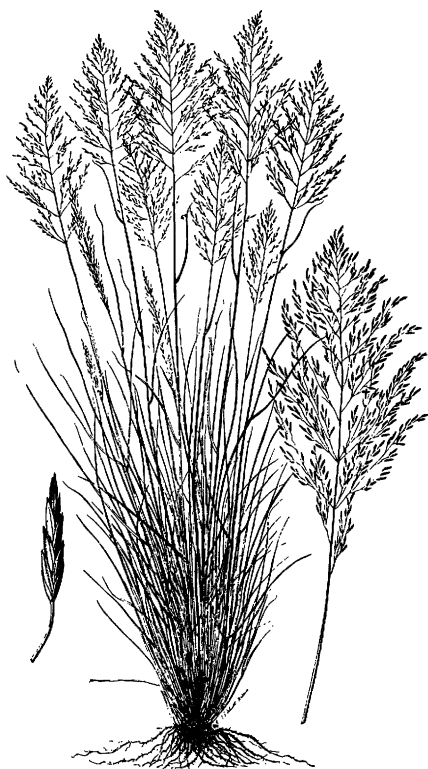
(*Eragrostis* species)

The genus lovegrass, *Eragrostis*, comprises 250-odd species and is represented in all temperate regions. Only a few species, some native and some recently introduced, have been recognized as of agricultural value in the United States. Several native species are considered weeds.

The name comes from the Greek *eros*, love, and *agrostis*, a kind of grass. Several species are recognized for their capacity to produce an abundance of seed and forage on soils of low fertility; hence they are used to provide vegetative cover on eroding sites.

The best known species is *E. abyssinica*, called Tef in Ethiopia, where it is cultivated as a cereal. It is cultivated also in India and Australia but usually as a forage plant. Although introduced at various times, it has never found a place in American agriculture.

In the United States where about 40 species occur naturally, only 4 have been noted as of much value. *E. obtusiflora*, ranging from New Mexico and Arizona southward into Mexico, is a hard and rigid perennial that spreads by rhizomes and thrives on alkaline



Weeping lovegrass

soil. It furnishes a great deal of forage in areas where it grows naturally.

Plains lovegrass, which grows on dry or sandy prairies in the Southern States, also has some value in New Mexico and Arizona as range forage and ground cover.

#### WEeping LOVEGRASS

(*Eragrostis curvula*)

Weeping lovegrass is a vigorous, perennial bunchgrass native to South Africa. It was introduced by plant explorers from the mountainous part of Tanganyika in 1927. Several importations of it have been made in the past 20 years; the most promising importation, from which the present seed stocks were obtained, was brought into the United States in 1934 and first tested and grown in the Southwest. This grass is particularly well adapted

to the soils and climate of the Southern Great Plains.

Weeping lovegrass plants produce seedstalks 2 to 5 feet tall and numerous slender, curving basal leaves 10 to 20 inches long. The heavy forage is eaten readily by cattle in early spring but sparingly in summer. The normal presence of green shoots in the bases of the plants often induces cattle to eat old growth in winter.

The plants resist summer heat and drought and survive temperatures as low as  $-11^{\circ}\text{F}$ . if the soil has adequate moisture at the time of the first killing frost.

Weeping lovegrass is easily established from seed. Its vigorous young seedlings quickly make an effective ground cover. The seed ripens in late June and thus escapes the hazards of the dry, hot midsummer. Seed yield per acre has amounted to 200 pounds under dry-land farming conditions and 600 pounds under irrigation.

Binders, headers, and combines have been used in harvesting seed. Recleaned seed should have a purity of 98 percent and germination of 85 percent. About 1,500,000 clean seed weigh a pound.

#### SAND LOVEGRASS

(*Eragrostis trichodes*)

Sand lovegrass, a vigorous, long-lived, native bunchgrass, occurs on sandy soils of the central and southern parts of the Great Plains. Plants normally grow to 3 to 6 feet. The elongated panicles are sometimes half as tall as the plant and have a distinctive purple color. The slightly hairy leaf blades are  $\frac{1}{4}$  inch wide and about 12 inches long. Leafy foliage, primarily basal, is abundant. Roots are vigorous, spreading, and deeply penetrating, and therefore of value in conservation.

Plants begin growth very early in the spring and remain green until late fall. It is generally considered one of the most palatable and nutritious of the range grasses, and frequently it suffers from continuous overuse.

Sand lovegrass is easily established from seed and volunteers aggressively. It makes excellent growth when seeded either alone or in mixture on sandy soils but does not thrive on heavy soils, except in pure stands.

Native stands are seldom suitable for seed harvest because of the presence of brushy plants such as sand sagebrush (*Artemisia filifolia*), shinnery oak (*Quercus* spp.), or the skunkbush (*Rhus trilobata*). Seed yields have exceeded 400 pounds an acre under irrigation and 150 pounds on dry land.

Binders and combines have been used for seed harvest. Cleaning the seed with a fanning mill should result in a purity of 98 percent and a germination of 75 percent.

### CENTIPEDEGRASS

(*Eremochloa ophiuroides*)

Centipede grass is a native of south-eastern Asia. It was first introduced into the United States in 1919 from China. It has been distributed in the Southern States and as far west as the Pacific coast. A low-growing perennial, it spreads by stolons. In appearance it is intermediate between carpetgrass and Bermuda-grass; it has shorter nodes than the latter and makes a dense mat of creeping stems and leaves.

Centipede grass is adapted to a wide range of soils, especially on the Coastal Plains of North Carolina to eastern Texas. It will grow on clay soils and the poorest Norfolk sand if enough moisture and plant food are available for it to get started. It has withstood temperatures of 12° F. or slightly lower, but it is not adapted to conditions in the North.

Because of its low nutritive value, its best use is for lawns and erosion control. It is not suitable for heavy or intensive use, such as on airport runways. In pastures it generally has given poor livestock gains. Because of its dense and aggressive growth it crowds out desirable legumes. Chemical analysis of grass samples, even in young vegetative growth, resembles (with



Centipede grass (vertical)

some variations) the analysis of cereal straws. The crude fiber is higher in centipede than in straw, but the fat- and nitrogen-free extract is lower.

Centipede grass will grow well on poor soils, but a complete fertilizer will encourage a more rapid spread and dense turf. Nitrogen fertilizer gives a most noticeable effect; there is no specific need for limestone. Because of its low fertility requirements, it is a desirable lawn or turf grass on low-fertility soils when costs of maintenance must be kept low.

Seed is unavailable in commercial quantities, and plants or stolons must be used. To establish new stands, a seedbed should be prepared as for any crop; then furrows, 2 to 3 inches deep



Meadow fescue

and about 10 to 18 inches apart, should be opened. The plants or stolons are placed about 6 inches apart in the furrows and covered immediately to prevent drying, with an inch or more of the plant left protruding above the surface. A closer spacing of rows and plants in the row gives a quicker establishment and cover. If the stolons are well watered and top-dressed with nitrogen, growth will be more rapid.

Spring-planted stolons have spread as much as 8 to 10 feet in a season. Approximately 15 to 20 pounds of stolons should set about 1,000 square feet of lawn at the rates given.

Its vigorous growth habit and ability to produce some seed make eradication rather difficult. It is therefore not recommended in places where it might become a pest.

## THE FESCUES

(*Festuca* species)

The fescues compose a large genus of which there are about 100 species in temperate or cool zones. They vary in texture and growth. Some are annuals, some perennials; some are low and others are rather tall; different ones are fine, coarse, tufted, creeping, erect, and so on. Thus they comprise a versatile group of varying uses.

The annual species are weedy, but the perennials are excellent for forage and turf. The several species that are cultivated as pasture grasses can be classified as the broad-leaf and the fine-leaf species.

Of the broad-leaf species that currently are most widely used, meadow fescue (*Festuca elatior*) and tall fescue (*F. elatior* var. *arundinacea*) are outstanding. Of the fine-leaf species, red fescue (*F. rubra*), Chewings fescue (*F. rubra* var. *commutata*), and sheep fescue (*F. ovina*) are perhaps the most useful.

### MEADOW FESCUE

(*Festuca elatior*)

Meadow fescue, a hardy perennial, is believed to have been introduced into the United States from Europe, probably England, where it is a standard grass.

It flourishes in deep, rich soils; where it is adapted it will usually grow to 15 to 30 inches. The leaves are bright green and rather succulent. The leaf sheaths are smooth and reddish purple at the base, and the young leaves involute in the bud. The blade

is glossy on the under surface. The panicles are open, similar in appearance to those of Kentucky bluegrass, although much larger and coarser. It flowers in June and July.

It does not propagate itself by rootstocks or form a dense sod. It produces comparatively few culms, and produces an abundance of highly germinable seed. The seed, which is easily harvested and cleaned, weighs 22 to 27 pounds to the bushel; there are 225,000 seeds in a pound. The usual rate of seeding is approximately 25 or 30 pounds to the acre.

Some years ago all seed of meadow fescue was imported, but now most of it (1,235,000 pounds a year between 1940 and 1946) is produced in the United States. The seed yield fluctuates considerably. Fields 2 or 3 years old are the most productive, but some that have been in for 8 or 10 years average 300 pounds of seed an acre.

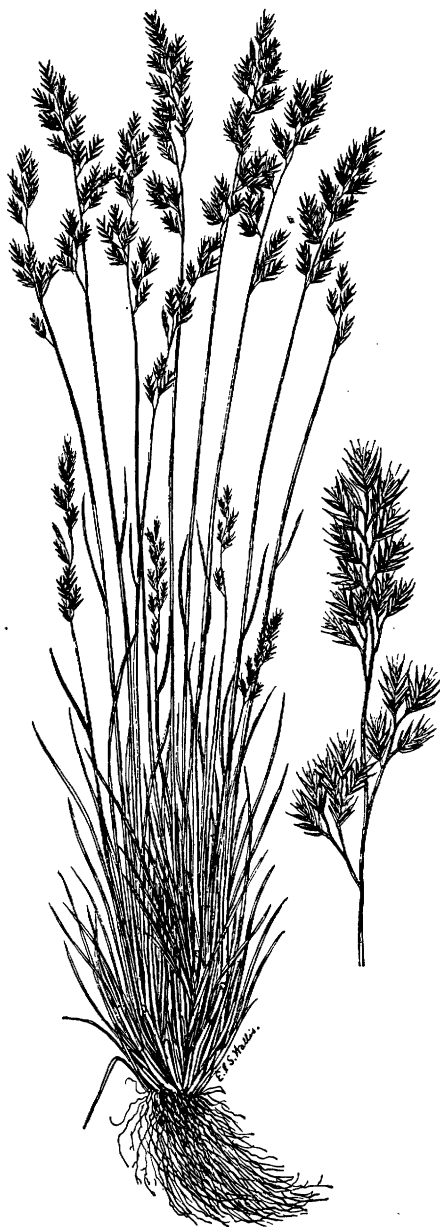
Weeds that make it hard to maintain stands of meadow fescue include chess or cheat (*Bromus secalinus*) and whitetop fleabane (*Erigeron strigosus*). Cheat has always caused trouble in meadow fescue stands because its seeds closely resemble those of the fescue.

Meadow fescue can be grown well throughout the timothy region and also farther south and west because it can withstand more heat and drought than timothy. In regions where it is adapted it is grown to a limited extent for pasture and hay. In the past it was commonly used in pasture mixtures, especially on soils that tend to be wet, but it is being used less and less for hay and pasture because of the improvement and increase in the production of tall fescue.

#### TALL FESCUE

(*Festuca elatior* var. *arundinacea*)

Tall fescue is a deeply rooted and strongly tufted perennial with stems 3 to 4 feet high, erect and smooth. The numerous dark-green basal leaves are broad and flat, the sheath is smooth, and the ligule is short. The nodding



Sheep fescue

panicle head is 4 to 12 inches long and has lanceolate spikelets that are  $\frac{1}{2}$  inch or more long and many-flowered. This variety, like the species, flowers in June and July.

Tall fescue is found growing in

damp pastures and wet places throughout Europe, North Africa, and North America. It can be distinguished from meadow fescue by height, its broad leaf, and the deep green of the upper surface of the leaf, which is prominently ribbed and rough.

Tall fescue was introduced from Europe probably about the same time as meadow fescue. Two strains, Alta and Ky. 31, are receiving the most attention now. Alta fescue is a selection made from a 4-year-old stand of tall fescue in Oregon in 1923; Ky. 31 is an increase from tall fescue found in 1931 on a Kentucky farm, where apparently it had been growing for something like 50 years.

Tall fescue is adapted to a variety of soils and in general to the same region as meadow fescue. Like meadow fescue, it does best on heavy soils that have considerable humus. Somewhat coarser and taller than meadow fescue, tall fescue is higher in forage yield and longer-lived.

The exact forage and pasture value of tall fescue has not been determined, but it will grow well in wet as well as in dry situations. In the Pacific Northwest, Alta fescue is rather widely used for pasture for cattle and sheep. Indications are that it may be desirable for winter pasture in the South. Farther north it may serve well for pastures of somewhat low fertility. It is quite drought-resistant and aggressive; it competes strongly with the legumes and sometimes wins out over them. It is less palatable than brome grass, orchardgrass, or timothy.

#### SHEEP FESCUE (*Festuca ovina*)

Sheep fescue, probably a native of the Northern Hemisphere, is a bunchgrass that forms dense tufts with numerous stiff, rather sharp, bluish-gray leaves. It is adapted to about the same climate as bluegrass and can be grown in the most northern agricultural areas. It succeeds better than most grasses on sandy or gravelly soils. Cat-



Red fescue

tle and sheep will graze sheep fescue but it is not generally recommended

for pastures—its greatest use is for making a durable turf on sandy soils. The commercial seed comes from Europe. The seed weighs 10 to 15 pounds per bushel. The usual rate of seeding is 25 to 30 pounds to the acre.

**RED FESCUE**  
(*Festuca rubra*)

Red fescue resembles sheep fescue, but its leaves are bright green and it does not grow in tufts. It creeps by underground stems.

From the commercial standpoint, there are two distinct forms, red fescue and Chewings fescue.

The first is a creeping grass, although this characteristic is rather variable, for some strains are more creeping than others. This may account for the use of the common name creeping red fescue in an attempt to make a distinction between strains.

Chewings fescue is cespitose or tufted and does not creep. It has been assumed by some that Chewings and red fescue had a common origin; that can hardly be true because both occurred in Europe and were described before they were of commercial importance.

Like sheep fescue, they are hardy, robust plants. They are used mainly for lawns and good turf and are especially adapted to shaded, dry sites.

Much of the seed of both red and Chewings fescue used in the United States is produced here or in Canada. Large amounts used to be imported from Europe, Australia, and New Zealand. Several new strains have been produced, but their general regions of adaptation have not been determined. These include the Illahee and Rainier strains from Oregon and the Olds strain from Canada.

**THE RYEGRASSES**  
(*Lolium* species)

The common name, ryegrass, is applied to a group of plants comprising two species of the genus *Lolium*. One, *L. multiflorum*, is known as Ital-



Italian ryegrass

ian ryegrass, and the other, *L. perenne*, as perennial ryegrass. The two species are closely related morphologically and their cultural practices are practically the same.

Italian ryegrass, usually an annual, is generally distinguished from perennial ryegrass by the awned lemma and stem characters and by the arrangement of the leaf in the bud. Awns are present on seed of Italian ryegrass and



Perennial ryegrass

are usually absent on perennial ryegrass. The culm or stem of Italian ryegrass is cylindrical but that of perennial ryegrass is slightly flattened. The leaves of Italian ryegrass are rolled in the bud. In perennial ryegrass the leaves are folded in the bud. The plants of Italian ryegrass are yellowish green at the base. Those of perennial ryegrass are commonly reddish.

Italian ryegrass, a native of the

Mediterranean region, apparently was first cultivated in northern Italy; it was known in Switzerland in 1820 and in France in 1818.

Perennial ryegrass was the first of all perennial grasses to be grown in pure stands for forages. It was mentioned in agricultural literature in England in 1611. It occurs naturally in all of temperate Asia and in north Africa. It succeeds best in cool, moist regions that have mild winters.

In this country best results have been had with it on the Pacific coast and in the central and southern parts of the Atlantic States. The hot, dry weather of July and August affects the growth; if drought continues into September, the recovery is slow. Like Italian ryegrass, it has a wide range of adaptability to soils, but it prefers medium to high fertility. In some sections the grasses are considered wet-land grasses, although production usually declines as the drainage gets poorer.

Italian ryegrass is more valuable as a hay plant on the Pacific coast than anywhere else in the United States. It makes an excellent temporary pasture and gives a quick cover for early grazing in permanent pastures. When sown in combination with winter grains for temporary pasture, it makes a desirable bottom grass and increases the length of the grazing season. Italian ryegrass is a most desirable annual grass for temporary poultry range. In the South it is used extensively for fall seeding on permanent lawns in order to furnish a green cover in winter. It also makes a good temporary lawn because it produces a turf quickly.

The principal use for perennial ryegrass in this country is for permanent pasture seedings. It starts growth early in the spring and affords grazing while the more permanent or longer-lived grasses are becoming established. Because of the toughness of its leaves, which makes it hard to mow, perennial ryegrass is not usually considered desirable for lawns—nor will it give a good turf in the summer months.

The ryegrasses can be seeded in the

fall or early spring. Spring seedings are preferable where winters are severe. Fall seedings are more successful in more temperate regions. Seed may be broadcast by hand or with an endgate seeder and covered with a smoothing harrow, or it can be sown with a grain or grass-seed drill. The seed should be covered with approximately one-half inch of soil. When the grain drill is used it may be necessary to reduce the size of the seed outlets to prevent sowing too much seed.

When seeded alone for forage or seed production, 20 to 25 pounds of seed per acre is sufficient. When seeded with small grain or a legume for annual pasture, 8 to 10 pounds per acre will give a satisfactory stand. When it is seeded on established grasses to furnish green lawns for winter, or when it is seeded alone in spring or fall for a temporary lawn, 3 to 5 pounds per 1,000 square feet is used.

Very little seed of pure Italian ryegrass is produced in the United States. Domestic-grown seed sold as such is a mixture of annual and perennial types; many intermediate types have resulted from field crossing. Such types are generally called common ryegrass, although they are classified as *Lolium multiflorum*.

Practically all the seed of common ryegrass and perennial ryegrass is produced in the Pacific Northwest. Harvesting practices are the same as for small grains. Because the seed shatters easily, larger yields are obtained by cutting with a header or binder when the seed is in the hard-dough stage. Average seed yields are from 600 to 700 pounds an acre. Approximately 275,000 seeds make a pound of Italian ryegrass; seed of perennial ryegrass is slightly smaller.

Improved strains of the ryegrasses are not in commercial production in the United States. Some seed is imported from Great Britain, other parts of Europe, Australia, and New Zealand. Limited amounts of varieties like Westerwold and Wimmera ryegrass are imported; both are true annuals.

## INDIAN RICEGRASS

(*Oryzopsis hymenoides*)

Indian ricegrass, a densely tufted, native, perennial bunchgrass, is widely distributed over the Western States. The genus name *Oryzopsis* is derived from the Greek words *oruza*, rice, and *opsis*, appearance.

The plump, milletlike seeds are nearly round, black, tipped with a short awn, and densely covered with conspicuous white hairs. Once they were a food staple of the Indians; particularly when the corn crop failed, seed of ricegrass was gathered in quantity, ground into meal or flour, and made into bread.

The plants grow from 1 to 2 feet tall. The slender leaves are nearly as long as the stems. The delicate spreading panicle has long pediceled spikelets and lemmas with hairs that are conspicuous and silky.

Indian ricegrass occurs mainly on dry sandy soils and frequently is important on sand dune areas. It is drought-resistant and somewhat tolerant of alkali. Once it was widely distributed over the western ranges, particularly in semidesert areas, but overgrazing on much of the land there has almost eliminated it. Now it grows in abundance in some places that have been ungrazed or conservatively grazed—places, for example, that are inaccessible to livestock or remote from watering places. Stockmen regard the grass highly as a winter feed for animals and prize the areas where it grows.

Seed formation in native stands is erratic, but when seasonal rainfall is plentiful, a good crop of seed can be expected. The seed can be harvested satisfactorily with a combine and cleaned by processing with a hammer mill to remove the silky hairs from the seed coats. About 140,000 clean seeds make a pound.

Seeding rates of 8 to 10 pounds of clean seed to the acre give satisfactory stands. Initial thin stands will increase in density if natural reseeding is per-



Indian ricegrass

mitted by careful management. Seed can be produced economically from cultivated row plantings.

The low germination of newly harvested seed is due partly to the hard, moisture-resistant seed coat. To break the natural dormancy and permit good germination, the seed should be scarified, treated with acid, or held a year in dry storage. Good germination may also occur if the newly harvested seed is planted in the fall, so that natural changes in soil temperature can soften the seed coat.

Indian ricegrass is important for

range reseeding because of its drought resistance, palatability, and capacity to grow and spread by natural reseeding on areas where practically no other grasses can be established.

## THE PANICGRASSES

(*Panicum* species)

The *Panicum* genus includes approximately 500 species that grow chiefly in warm regions of the world. The species native to the United States occur primarily in the Southeast but are well represented also in the warmer parts of the West.

Panicgrasses belong to the millet tribe, *Panicum* being the Latin name for millet. Proso (*Panicum miliaceum*) is believed to have been the first cereal cultivated by man.

## VINE-MESQUITE

(*Panicum obtusum*)

Vine-mesquite is a vigorous, long-lived, native perennial of the Southwestern States. The stiff, erect culms are 1 to 2 feet tall; leaves are 4 to 6 inches long and about  $\frac{1}{4}$  inch wide. Stolons are numerous, often several feet long, with swollen hairy or woolly nodes. The seed panicle is 2 to 5 inches long with a few racemelike branches.

This grass grows where rainfall is scant but is generally most abundant where additional water is received in occasional floods.

It produces a fair amount of forage, which livestock relish when it is green and succulent. Ranchers differ in their opinion as to the feeding value of the forage as it approaches maturity, however; some maintain that stock will not eat the mature plants if other feed is available.

Seed is rather hard to get and is generally of low quality, an undesirable feature that is offset somewhat by the ability of the plants to spread rapidly by stolons, which may grow 15 feet in a single season. The plants therefore can well be propagated by transplanting sod pieces. Vine-mesquite hay, cut after

the seed heads mature, can be used as another means of establishing new seedings.

### SWITCHGRASS (*Panicum virgatum*)

Switchgrass is a vigorous, native, perennial, sod-forming grass that occurs throughout most of the United States. It is most abundant and important as a forage and pasture grass in the central and southern parts of the Great Plains. It usually grows 3 to 5 feet high, with short, vigorous rhizomes. The stand looks like a colony rather than a sod. The flowering head is a widely branching open panicle. The leaves are usually from one-fourth to one-half inch wide and 6 to 18 inches long. Leaves are green to bluish-green. Switchgrass occurs on nearly all soil types but is most abundant and thrives best on moist low areas of relatively high fertility.

Heavy, vigorous roots and underground stems make the species excellent for conservation use. Seedling growth is aggressive. Usually switchgrass is seeded with the species with which it occurs naturally. Best seedling stands have been obtained where plantings were made on a clean, firm, well-prepared seedbed.

Growth begins in late spring and continues through the summer if there is enough moisture. Forage is produced in abundance and—especially during the period of early rapid growth—is acceptable to livestock. Hay of good quality can be had by mowing the grass when seed heads begin to form.

The seed matures in September. The amount produced depends on moisture and cool temperatures during the period of blooming and seed formation.

Binders and combines have been used for seed harvesting. Native stands commonly yield more than 100 pounds of seed per acre; this yield can be increased to 300 pounds by growing the plants in rows under cultivation.

Recleaning the seed with a fanning mill should give a purity of 95 percent



Switchgrass

and a germination of 30 percent. Germination improves during storage and may be twice as high if the seed is held in dry storage for a year after harvest.

A pound of pure seed contains 370,000 to 420,000 seeds.

Blackwell, a new and improved variety developed through plant selection and breeding work at the Kansas Agricultural Experiment Station, yields excellent forage and shows considerable resistance to stem rust, a disease that is injurious to most native switchgrass plants. Seed of Blackwell is being produced by seed growers of the Kansas Crop Improvement Association under field inspection and certification.

### THE PASPALUM GRASSES (*Paspalum* species)

Of the 400-odd species of *Paspalum*, few have economic importance in the United States. The most important are



Dallisgrass

Bahiagrass (*Paspalum notatum*) and Dallisgrass (*P. dilatatum*). Vaseygrass (*P. urvillei*) and ribbed paspalum (*P. malacophyllum*) are of minor value.

Dallisgrass is an upright-growing

bunching grass, and is the most winter-hardy and most widely adapted of the four species. It can be grown as far north as the Carolinas and thrives in the irrigated sections of the milder parts of the Southwestern States. It was first introduced into the United States about 1875, probably from South America.

Dallisgrass requires a moist but not wet soil; growth is best where organic matter is abundant. It requires a higher fertility than carpet or Bahia-grass. Because it seldom forms a dense sod, it is an excellent grass to mix with legumes and other grasses.

Seeded alone, it often fails to make a perfect stand. Dallisgrass produces abundant seed, but the germination is often poor because of the fungus disease ergot (*Claviceps paspali*), which attacks or destroys the seed.

Most of the domestic-grown seed is produced in Louisiana, Mississippi, and Alabama. Because the seed is produced throughout the summer, it is possible to harvest two crops or more in a season.

Vaseygrass resembles Dallisgrass but it is taller and more erect. It is best adapted to fertile soils and is common in the South along highways or railroads where it has not been heavily grazed. Because of its erect growth it can be easily eradicated by close, continuous grazing.

Ribbed paspalum, a more recent introduction from Brazil, also resembles Dallisgrass but is finer-stemmed and has more erect growth. It produces an abundance of seed, but the seed rapidly loses its vitality. Like Vaseygrass, it requires careful management because it is injured by heavy grazing.

Bahiagrass is a low-growing perennial that was also introduced from South America. It differs from Dallisgrass in that it spreads by short, heavy runners and forms a dense, tough sod even on droughty, sandy soils. Common Bahia is less winter-hardy than Dallisgrass but survives the winter in the Southern Coastal Plains when temperatures are not too severe.

Two new varieties of Bahiagrass, Paraguay and Pensacola, are now being increased in the United States. They are more winter-hardy and have narrower and more hairy leaves than the common Bahiagrass. Paraguay and Pensacola produce a good seed crop of excellent quality.

Seed of common Bahia is imported mostly from Cuba and Costa Rica. It does not germinate well unless treated in some manner, as with sulfuric acid, so as to make the seed coat more permeable to water.

*Paspalum* grasses are primarily pasture grasses. Some are short-lived, but Dallis and Bahia maintain good stands and remain productive for a long time if properly fertilized and managed. To establish new stands, seedlings should be made in the spring after corn-planting time—the latter part of April or early May. A good seedbed is essential. Lime and fertilizer should be applied ahead of planting and also in later years. Dallisgrass requires greater amounts of plant food than Bahiagrass for equal growth.

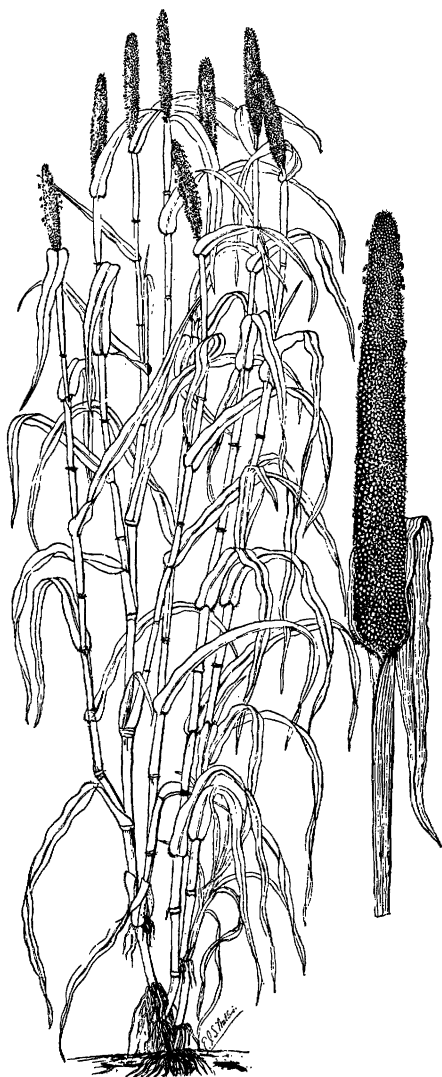
The main center of variability of these grasses appears to be in Brazil, where some of the species form the dominant cover over large areas.

Some 10 other species, native to southern Brazil, Uruguay, Paraguay, and adjacent Argentina, have been reported as valuable native forage in those countries. Efforts to obtain them and additional strains of Dallisgrass and Bahiagrass have met with only slight success. Exploration in temperate South America for *Paspalum* and other forage plants should give us other species of value for the South.

### PEARLMILLET and NAPIER-GRASS

(*Pennisetum* species)

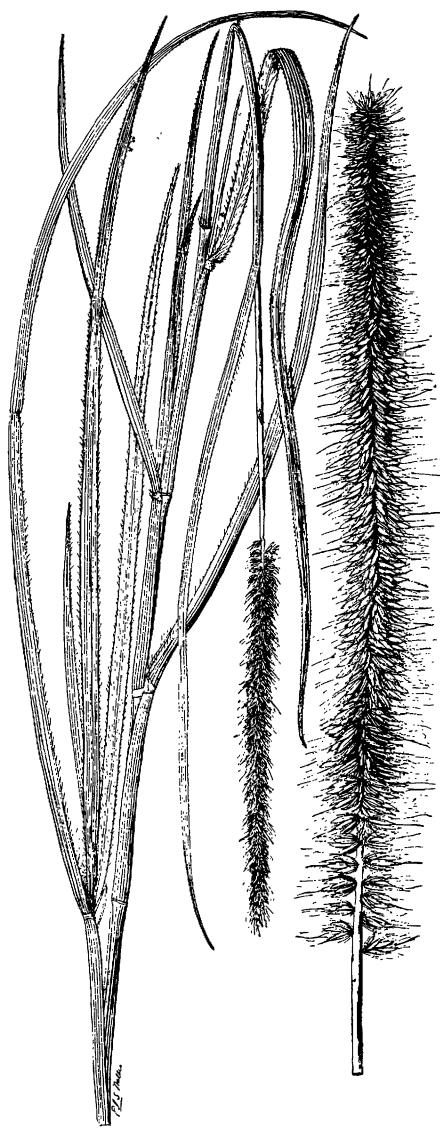
Of the many species of *Pennisetum*, only two are important for forage. Their common names are pearl millet and Napiergrass; their respective botanical names are *P. glaucum* and *P. purpureum*.



Pearlmillet

They are large, upright plants that grow 6 to 10 or more feet tall. The coarse stems grow in thick clumps. The leaves are about an inch wide, 2 to 3 feet long, and quite numerous in both species. The flowers are borne in terminal spikes 6 to 12 inches long. Pearl millet is an annual; Napiergrass is a perennial. Both have come to us from Africa.

Pearlmillet was introduced into the United States many years ago; we do



Napiergrass

not know the exact date. It came by way of the West Indies from India, where it is considered an important forage plant. Napiergrass, introduced in 1913, is grown in several countries, particularly Africa and Australia, but in no place is it used extensively. Both grasses now are considered of importance in sections of the South, where they are used for grazing and silage.

Both grasses require a rich soil for best growth. Under favorable conditions they produce enormous amounts of green fodder and can be cut several times a season. They are warm-climate crops and grow only in the warmer part of the year. Napier, being slow in establishment and perennial, cannot be grown except in regions having but little or no frost. Pearl millet, a summer annual, will mature seed as far north as Maryland, but it can be used economically only farther south.

Pearlmillet seed is planted directly in the field where the crop is to be grown. It is commonly planted in 4-foot rows; 4 pounds of seed to the acre give good results.

When Napiergrass is grown from seed, the seeding is made in greenhouse flats or a nursery; the plants are transplanted to the field. The more common practice with Napiergrass, however, is to grow the crop from planted canes. The mature stocks or canes are cut into short lengths that contain one to three nodes, which are planted in rows and covered as one would cover potatoes or other crops that are reproduced vegetatively. Plantings of Napiergrass will continue to produce for a number of years, but old stands decline in productive value and should occasionally be renewed.

A fine-stemmed strain of Napier has been called Merker grass; actually, it is only a selected variant. Other names, such as elephant grass and Carter grass, also are used for this.

Pearlmillet is sometimes known as cattail millet.

Improved strains of Napiergrass that are more disease-resistant and furnish superior grazing and production have been developed in Florida and Georgia.

## CANARYGRASSES

(*Phalaris* species)

The canary grasses, both the native and introduced species, are widely distributed throughout the world, although those in the United States are not so numerous as most other genera.



Reed canarygrass

The canarygrasses are annuals or perennials. Most of the ones found in the South are winter annuals; some of them occur in the North as summer annuals. The common name, canarygrass, probably had its origin from the fact that the seed of *Phalaris canariensis* has long been used as canary bird feed. Reed canarygrass, *P. arundinacea*, is a leafy perennial of wide agricultural importance in this country as a wet-land grass.

Hardinggrass, *Phalaris tuberosa* var. *stenoptera*, a perennial of recent introduction, has given good yields of forage in places where winter weather is relatively mild and soils are fertile. Hardinggrass is an outstanding forage grass in Australia. Most of the canarygrasses are nutritious and palatable to livestock. They grow most rapidly during the cool seasons.

Reed canarygrass was recognized as a good forage plant in Sweden about 1750. Its use in southwestern Oregon about 1885 has been reported. It is adapted to the northern half of the United States; the largest acreages now are in Oregon, Washington, northern California, Minnesota, Wisconsin, and Iowa. It is being used more and more for waterways and for seeding on wet pastures.

Reed canarygrass grows in clumps that often are 3 feet across. The dense heads are 2 to 8 inches long and become whitish as the seed matures. It makes its best growth in fertile and moist or wet soils, and is one of the best grasses for swamplands of a muck and peat nature. Contrary to earlier opinion, it is adapted and makes excellent growth on upland soils that are frequently dry for long periods in summer. It is winter-hardy and grows most rapidly during the cool spring months. Its long life, long grazing season, and large yields of nutritious, palatable forage make it a valuable pasture plant.

It will not survive under continuous, close grazing. Its use as a silage crop is increasing. Yields of 3 to 4 tons of hay in a season are not at all uncommon.

Early cutting of the hay crop improves the quality; otherwise it may be somewhat coarse.

Seed is harvested in all the regions where the grass is grown. The mature seed shatters so readily that it is frequently hand harvested. Grain binders are sometimes used for harvesting, but seed losses are high. Seed yields are from 30 to 150 pounds an acre.

Hardinggrass resembles reed canarygrass in general appearance, growth, and cultural practices. The principal differences are the more compact seed head of the Hardinggrass and its less spreading rootstocks. Also, the seed of Hardinggrass shatters less freely and harvesting is easier. The annual species, *Phalaris canariensis*, makes an upright growth, with little stooling. It can be seeded and harvested like wheat and other small grains.

## TIMOTHY

(*Phleum pratense*)

Timothy is of European origin but it was first cultivated in the United States. It was once called Herd's grass after the man who found it growing along the Piscataqua River near Portsmouth, N. H. The earliest record of the name timothy is from a letter dated July 16, 1747, to Jared Eliot from Benjamin Franklin, who states that the Herd's grass seed received proved to be "mere timothy." The designation "timothy" may be derived from the name of Timothy Hansen, who apparently brought the grass from New England to Maryland. In 1807 timothy was the most important hay grass in the United States; for many years its supremacy in this country was never threatened.

The stems or culms are 20 to 40 inches tall. They emerge from a swollen, or bulb-like, base and form large clumps. Timothy differs in one respect from most other grasses in that one (sometimes two) of the lower internodes is swollen into an ovoid body, which is referred to as a "bulb" or "corm" although it really is only a

thickened internode. Each one of these "corms" is annual in duration, forming in early summer and dying the next year when seed matures. The leaves are elongate. The panicle is cylindrical and commonly 2 to 4 inches long and often longer.

Timothy grows better on clay loams than on light-textured, sandy soils. It is well adapted to the cool humid climate of the Northeastern and North Central States and also to the valleys of the Rocky Mountains and to the coastal region of the Pacific Northwest.

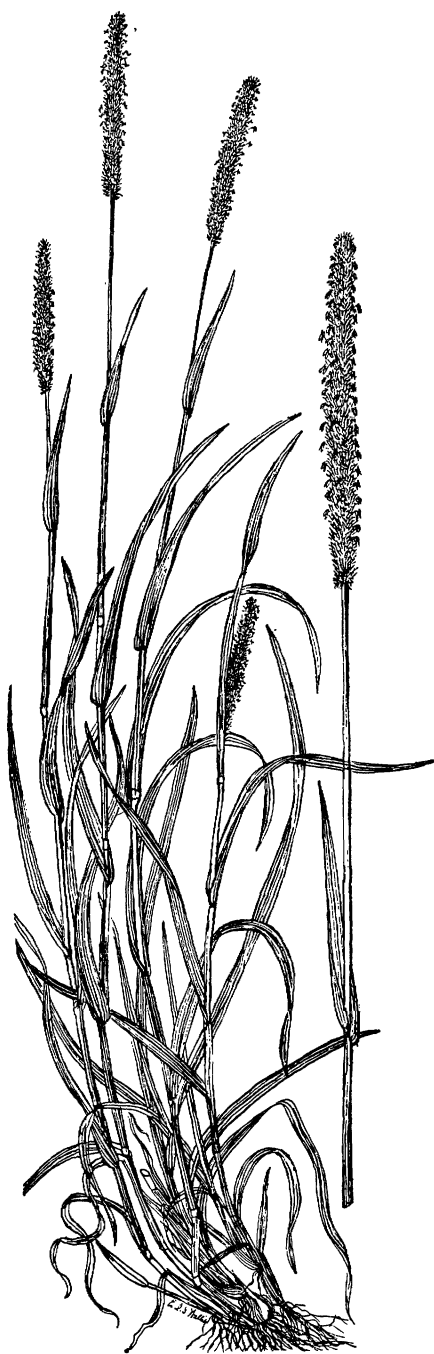
Fall seedings are best when seeding alone or with winter wheat; seedlings started then are less likely to be injured by dry weather in late spring or early summer than are seedlings from spring seedings. Less seed is required for fall than for spring seeding.

From 3 to 5 pounds an acre is recommended for fall; 10 pounds is recommended for spring seeding. It is commonly sown with clover—medium red, mammoth, or alsike—or with alfalfa in order to get a hay with higher protein content and to maintain a better soil productivity.

A change in the quality of hay occurs as the season advances. The percentage of nitrogen-free extract, fat, and protein gradually decreases while the less digestible and less valuable crude fiber increases with maturity. Therefore, timothy should be cut when it is in early bloom in order to get the greatest value per acre of high-quality hay.

About 6 percent of the timothy acreage of the United States is harvested for seed each year. Most of the domestic seed is harvested in a few Western States. The acreage cut for hay is estimated at more than 6 million in the United States.

The genus *Phleum* contains about 10 species. Half of them are annuals. All are native to Eurasia except *P. alpinum*, which is spread throughout the cold and mountainous parts of the Northern Hemisphere and as far south as the mountains of South America. Most of the species have been intro-



Timothy

duced into the United States, but only timothy is cultivated.

## THE BLUEGRASSES

(*Poa* species)

Approximately 200 species of *Poa* are distributed through the world, primarily in the temperate and cooler regions. The 65 species native to the United States include some commercially important cultivated grasses. The genus name is from the Greek word *poa*, which was applied to any plant that could be used as fodder for livestock.

The *Poa* genus is distinguished by small, awnless spikelets; lemmas with a heavy midnerve like the keel of a boat; glumes, one- to three-nerved; and flat or folded leaf blades, with boat-shaped tips.

The bluegrasses are valued primarily for pasturage, hay, and lawn. They rank as the most palatable of range and pasture grasses and are suited for many special agricultural uses.

The most important are *Poa pratensis*, more commonly known as Kentucky bluegrass, and *P. compressa*, or Canada bluegrass. They are natives of the Old World. Kentucky bluegrass is quite extensively used for lawns, for turf on fairways and tees of golf courses, and for permanent pastures. Canada bluegrass is most useful as a pasture grass.

Generally, the bluegrasses should be planted in autumn because temperature and moisture then conduce to germination and promote good growth.

For a vigorous growth and a desirable dark-green color, nitrogen is the nutrient needed most where bluegrass is used for lawns. Nitrogen is the element most frequently found lacking where the grass has indications of underfeeding. However, when bluegrass is used for pastures and especially where seed production is the aim, attention should be given to other nutrients as well, because too much nitrogen will tend to delay flowering and seed production. Phosphorus also stimulates growth. For best growth and seed production, then, phosphorus, potassium, and nitrogen must be plentiful. Unless



Kentucky bluegrass

the soil is quite deficient in calcium, lime is not necessary.

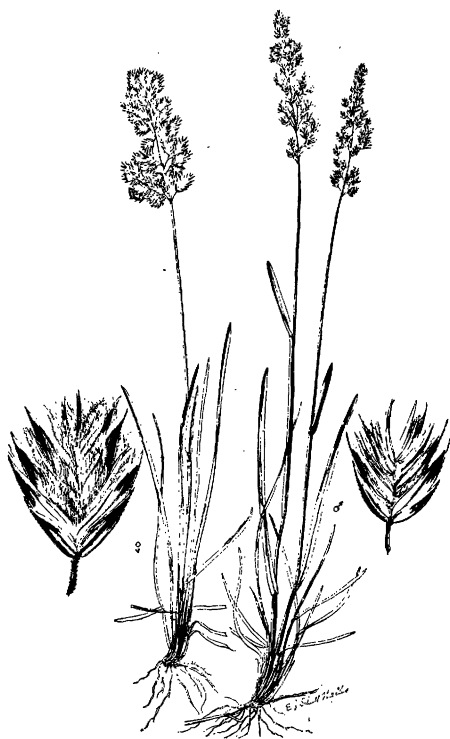
Other species of bluegrass that are well known and have their place in agriculture are the *Poa arachnifera* (Texas bluegrass); *P. trivialis* (rough-stalk bluegrass); *P. bulbosa* (bulbous bluegrass); *P. annua* (annual bluegrass); *P. ecunda* (Sandberg bluegrass); and *P. ampla* (big bluegrass).

### KENTUCKY BLUEGRASS

(*Poa pratensis*)

The Kentucky bluegrass (sometimes called junegrass) is used principally for lawn and turf purposes but is also extensively used for pasture.

The definite date of its introduction into the United States is not known. It is believed to be a native of the Old World; it occurs over much of Europe and Asia. Probably the early colonists brought seed of Kentucky bluegrass to



Texas bluegrass

this country in mixtures with the other grasses. Apparently the climate and soil of the Northern States and the mountainous and cooler localities farther south were hospitable, for it is so widely distributed throughout those regions that its origin is often questioned.

Kentucky bluegrass grows 18 to 24 inches tall and under exceptionally favorable conditions often reaches 36 inches. It is easily identified by its boat-shaped leaf tip. It is a long-lived perennial. Some fields of it are known to be more than 60 years old. It spreads by underground rhizomes and thus makes a dense sod. The open, pyramidal panicle produces much seed.

It is dormant during exceptionally hot, dry periods of summer and turns brown unless ample water is applied. It is quite attractive, however, in the fall and spring and is more or less green in winter when it is properly managed and fertilized—an important factor in lawns.

### CANADA BLUEGRASS

(*Poa compressa*)

Canada bluegrass resembles Kentucky bluegrass but is different from it because of its blue-green foliage, distinctly flat culms, and short and much contracted panicles. It also is rhizomatous and spreads by these underground rootstalks. It is a native of Europe. It is extensively naturalized in this country. It is adapted to open, rather poor, dry soils, and in such situations competes with Kentucky bluegrass as a pasture grass. For lawns and golf links and similar purposes it can be used to advantage under conditions too dry or otherwise not entirely favorable to Kentucky bluegrass. Seed is produced quite abundantly and is easily harvested and threshed.

### ROUGHSTALK BLUEGRASS

(*Poa trivialis*)

Roughstalk bluegrass, known also as roughstalk, resembles Kentucky bluegrass but differs from it in that it has no creeping rootstocks. The branches of the panicle are more slender and spreading. It also is a native of Europe, where it is a prominent pasture grass in many districts. It is used to some extent in this country as a wet-pasture grass, but it is used most often as a grass for seeding mixture for shady lawns.

### BULBOUS BLUEGRASS

(*Poa bulbosa*)

Bulbous bluegrass is thought to be a native of southern Asia, Europe, and north Africa. It grows in nearly all temperate and subtropical regions. It was probably inadvertently brought into the United States in seed of other grasses and clovers. It is grown most extensively in southern Oregon and northern California.

Bulbous bluegrass forms true bulbs at the base and bulblets or bulbils in the panicle. Only rarely do the plants produce perfect flowers on the culms

## ANNUAL BLUEGRASS

*(Poa annua)*

Annual bluegrass, as the name implies, is an annual. It normally begins growth in late summer or early fall from seed produced earlier the same year. It is more dwarfed in growth than Kentucky bluegrass and lacks creeping rhizomes. It also has shorter, broader leaves than the other bluegrasses and the color, a considerably lighter green than that of Kentucky bluegrass or the others, is distinctive. The entire plant is smooth. The leaves are shiny on the dorsal side. No other turf species can produce seedstalks under regular mowing, but this grass can reproduce seeds even when mowed regularly at a height of one-fourth inch.

It is of little economic importance and under most conditions is considered a weedy pest, especially on lawns and golf courses.

## BIG BLUEGRASS

*(Poa ampla)*

Big bluegrass is a robust, perennial, native bunchgrass that grows in all parts of the West. Plants are tufted and vigorous, about 2 to 4 feet tall, and have numerous basal leaves. Leaf blades are pale green, flat, and about  $\frac{3}{8}$  inch wide and 8 to 16 inches long. Panicles are erect, dense, and from 4 to 10 inches long. The fibrous roots penetrate deeply.

Although seldom found in dense stands, big bluegrass is an important range species because of its heavy forage production, palatability, and tendency to begin growth in early spring and continue into the fall. Because of its wide distribution, extensive root system, and adaptation to adverse sites and climates, it is useful for regrassing abandoned farm land and depleted range land. For this purpose it is one of the most useful of the bluegrasses.

Heavy, continuous grazing and severe trampling are injurious to native stands, but if it is grazed in moderation it responds satisfactorily.



Canada bluegrass

or the seedstalks, and even these fail to develop a caryopsis or true seed. Growth usually begins about October 1 and ceases May 1 to May 15 when the bulblets formed in the panicle are mature. The seedstalks reach a height of 10 to 18 inches, depending on the fertility of the soil.

Bulbous bluegrass is best adapted to sections that have a dry summer, a mild winter, and winter rainfall. It grows during fall, winter, and early spring.

The production of seed (bulblets) on a commercial basis is confined largely to southwestern Oregon. Harvesting is done with a mowing machine with a swather.

The seeds are large and ordinarily are produced in abundance. When grown in rows and cultivated for seed production, big bluegrass has given excellent yields of good seed. Mixed field plantings of big bluegrass and legumes have produced high forage yields of good to excellent quality. This is particularly true of grass-alfalfa mixtures adapted to areas receiving limited rainfall.

Plant-selection work at Moro, Oreg., has resulted in development of an improved variety of big bluegrass named Sherman, which is now being grown for seed increase under State seed certification procedure. It should be ready for distribution before long.

#### TEXAS BLUEGRASS

(*Poa arachnifera*)

Texas bluegrass is a vigorous, sod-forming, native perennial that occurs in the Southeastern States and the warmer parts of the Southern Great Plains. This bluegrass is dioecious—a plant that produces pollen does not produce seed, and vice versa. The most characteristic difference in the appearance of the two kinds of plants is that the female plants have a mass of fine cobwebby hairs on their spikelets; the spikelets of the male plants are smooth and hairless.

Plants grow to a height of 1 to 3 feet, with numerous leaves  $\frac{1}{4}$  inch wide and from 6 to 12 inches long. Seed panicles are about 6 inches long, light greenish in color, and dense and somewhat spikelike in form. Long, webby hairs at the base of the lemma are very prominent.

Texas bluegrass grows through the winter, producing an abundance of leafy, nutritious forage at the season when most range forage is harsh and least palatable to livestock.

Because of the palatability and abundance of the forage it yields, this species is valuable for range and pasture in the area to which it is adapted, but its use for reseeding at present is limited by the paucity of the seed it

produces. Breeding work has been in progress for some time to increase its seed production, but no new varieties are yet available.

Processing the seed to remove the woolly, hairlike seed covering has been only partly effective.

#### SANDBERG BLUEGRASS

(*Poa secunda*)

The most common native bluegrass is Sandberg bluegrass. It is a glabrous, tufted perennial that occurs generally throughout the Northern Great Plains and the Western States.

Plants may grow to a height of 8 to 24 inches. The inflorescence is a panicle only about a half inch wide. The forage is scanty but palatable. Since Sandberg bluegrass begins growth early in the spring, it supplies green, succulent forage at a time when it is most beneficial to grazing animals. It usually matures and dries by the first part of July. It is considered highly drought-resistant—partly because of its habit of making early growth and then going into dormancy as available moisture becomes scant.

Fair crops of seed are produced, but viability is usually low. Seed can be harvested readily with small-grain harvesting combines.

When used for revegetation, this bluegrass is ordinarily seeded in mixtures with other adapted grasses. The first species of the mixture to begin growth, it is dominant in spring but yields dominance to other species of the mixture as the season advances.

#### MUTTON BLUEGRASS

(*Poa fendleriana*)

Mutton bluegrass (*Poa fendleriana*, syns. *P. brevipaniculata*, *P. longepedunculata*, and *P. scabriuscula*), also known as Fendler bluegrass and muttongrass, occurs from northern Michigan and northern Wisconsin to southeastern British Columbia, eastern Washington, California (east of the Sierra Nevada), east to the Chisos

Mountains of western Texas and south into the mountains of Sonora, Chihuahua, and Baja California.

It is a perennial bunchgrass, tillering from the base, characteristically without rootstocks although, very rarely, small rootstocks, or rhizomes, are produced. The erect, tufted stems, varying in height from 6 to 24 inches, are roughened below the flower cluster—the panicle. The tufts range up to about a foot in diameter. The leaves are mostly basal. The firm and rather stiff blades are folded or inrolled, rarely flat. The leaf sheaths are somewhat roughened. The ligule, the tongue-like appendage in the collar of the leaf sheath and an important identification mark in grasses, is very small and scarcely noticeable. The oblong, contracted, usually green or pale bluish-purple flower head is long-exserted from the top leaf sheath and up to about 3 inches long. The individual spikelets are 4- to 7- (mostly 5- or 6-) flowered, flattened, and about  $\frac{1}{3}$  inch long; the 2 glumes (the lowest and empty scales of a grass flower) are broad and  $\frac{1}{8}$  inch long. The lemmas, or flowering scales, lack the cobwebby hairs at the base so often found in the bluegrass genus, but have fine hairs on the lower part of the midrib and on the marginal nerves, the intermediate nerves being obscure.

Mutton bluegrass occurs in grasslands, in open stands of aspen and coniferous timber, on rocky slopes, and mesas. Its altitudinal range in the Far West is considerable, ranging from sagebrush types at around 4,000 feet to timber line at about 11,500 or 12,000 feet in the Rocky Mountains. It occurs on all slopes but especially on dry, southern exposures, chiefly inhabiting rich, well-drained clay loams, especially those of limestone origin, but it is also found in sandy and gravelly soils. In the northern parts of its range, this grass often occurs in the foothills and on lower slopes, but in the Southwest it characteristically grows at higher elevations, the lower slopes and mesas ordinarily being too hot and dry

in summer for bluegrass. In fact, this tufted perennial is probably the only native bluegrass sufficiently abundant in the Southwest to be of more than purely local importance.

Mutton bluegrass is resistant to drought and, to a considerable extent, fire—often it is found on burns. The flowering period varies from March to early June; seed dissemination varies from July to November. Frequent associates (among grasses) are species of brome, fescue, needlegrass, redtop, trisetum, and wild-rye, and (among range weeds) aster, cinquefoil, lupine, penstemon, senecio, and yarrow; also, sedges, sagebrush, and shrubby cinquefoil.

Mutton bluegrass is one of the more important native range grasses, due to its high palatability, nutritiousness, wide distribution, fair abundance, and the fact that it starts growth very early in the spring and consequently is available when there is little other forage. For example, on the Colorado Plateau its density is light and it furnishes not over 5 percent of the total forage, as contrasted with the far greater bulk of Arizona fescue (*Festuca arizonica*), but because of its exceptionally early growth and the fact that its flowering period immediately follows the melting of the snow when there is but little other green vegetation, the species is conspicuous and is one of few generally recognized by local stockmen, who often call it “wintergrass” or “winter bluegrass.”

It rates as excellent forage for cattle and horses and very good or good for sheep, elk, and deer, especially in early spring. The foliage becomes rather harsh and dry with increasing maturity, and the palatability decreases somewhat as the season advances, although it is grazed well throughout the summer. In fall, when more tender and succulent forage is scarce, cattle and horses readily eat the air-cured herbage. The common name “muttongrass” reflects the reputation of this species held by sheepmen for fattening sheep and lambs, especially in spring.

## FOXTAIL MILLET

(*Setaria italica*)

Foxtail millet has erect or ascending stems that mostly are simple but are sometimes branching. It grows 2½ to 5 feet high under cultivation and bears broad, flat leaves. The seeds are borne in a rather dense, cylindrical spike. Foxtail millet, an annual, was cultivated in China as early as 2700 B. C. and later introduced into Europe. In 1849 seed was distributed by the United States Patent Office and by 1899 it had become a rather important crop in the Central States. The grassy weed known as foxtail is a rather close relative.

Foxtail millet is grown throughout the Great Plains, as far south as northern Texas, east through Missouri, southern Iowa, and northern Arkansas, and across Tennessee, Kentucky, and southern Illinois and Indiana. It can be grown in almost any area that has warm weather during the growing season and enough rain for any other crop. In fact, it has a lower requirement than most other crops but is seriously damaged by severe drought.

A number of varieties are recognized, the better known being Common, German, Hungarian, Siberian, and Kursk. The German and Common are the ones most generally grown.

Foxtail millet is used as hay, pasture, and green fodder; the seed is used for bird feed. It is useful as a catch crop to supply supplemental feed when pastures fail or the hay crop is short.

The seed deteriorates rapidly, and fresh seed should be used. Seed 2 years old will have deteriorated but little if kept in good storage, but seed older than that usually has low germination. The weight of seed is from 48 to 60 pounds per bushel.

Fertilizers are not used with foxtail millet in the Great Plains. Farther east, nitrogen and phosphate particularly have given increased yields, but as a general rule fertilizer should be applied to other crops in the rotation rather than to the millet.



Foxtail millet

A good seedbed should be prepared by plowing, harrowing, and cultipacking or otherwise firming the seedbed. The seed is sown from shortly after corn-planting time to the middle of summer.

From 25 to 30 pounds of seed an acre should be used in places of ample rainfall and 15 to 20 pounds in drier localities. A grain drill should be used when foxtail millet is seeded alone. A mix-

ture of the millet and soybeans or cowpeas should be broadcast by hand or drilled separately.

Foxtail millet hay is fed to horses and cattle, but opinions differ as to its value. The feeding value is greatest from the time of the first bloom until the seed reaches the milk stage. The crop is cut with an ordinary mower, windrowed, shocked, or handled otherwise as one would any ordinary hay crop. Hay yields are from 1 to 3 tons, depending on fertility, moisture, and like conditions of growth.

Foxtail millet hay is usually considered inferior to timothy and some of the other tame grasses. It is less palatable and does harm to horses if it is fed as the sole roughage. Some farmers think it makes fairly good hay for cattle and sheep; and as roughage for growing stock, it is about equal to prairie hay but inferior to alfalfa and clover.

The seed crop is usually harvested with a grain binder and placed in shocks and handled like wheat or other small grain. Ordinary threshers are used in threshing by adjusting to proper screens and making other minor adjustments. Yields of seed up to 20 bushels an acre are obtained under favorable conditions.

Foxtail millet is often used as a cash crop in a regular rotation and as a catch crop following small grain or other late-spring- or early-summer-maturing crops.

## SORGHUMS and CONGENERS

(*Sorghum* species)

The forage sorghums, Sudangrass, and Johnsongrass are among our most important forage resources. The sorghums and Sudangrass are summer annuals that tolerate long, hot, dry periods of weather; thus they are particularly adapted to the Great Plains and valuable as emergency forage in the more humid areas. Johnsongrass, a rapidly spreading perennial where winter temperatures are not severe, is considered a serious weed in cultivated

fields, but it is valuable for hay and pasture in many parts of the Southern States.

All are of foreign origin. The sorghums were cultivated during ancient times throughout Africa and southern Asia. Johnsongrass is a native of the Mediterranean. Sudangrass was introduced from Africa.

### FORAGE SORGHUMS

(*Sorghum vulgare* and vars.)

On the basis of uses, the sorghums can be divided into four kinds: Grain, forage, sirup, and those for industrial brooms, wallboard, and so on. No clear distinction can be made between grain and forage sorghums, but those that have sweet or slightly sweet and juicy stems and the more leafy ones usually are classified generally as forage sorghums.

Sorghum generally is grown like corn; during the early stages of growth corn and sorghum look somewhat alike. The leaves are broad; the coarse stems grow from 2 to 15 feet high, depending on variety and growing conditions.

The seed is borne in heads composed of loose branches or panicles sometimes 8 inches thick and more than a foot long.

Because sorghums probably were cultivated in prehistoric periods in many parts of Asia and Africa, under widely different conditions of environment, hundreds of varieties have developed through natural selection. The sweet sorghums were introduced into the United States about 1850. Since then large numbers of varieties have been developed through selection and breeding.

Many of the sorghums used as forage are cut and fed later as fodder or silage.

The feeding of green sorghum to livestock, either by pasturing or soiling, is not widely practiced because of the risk of prussic acid poisoning. Losses in livestock from such poisoning is greatest when the second growth or a stunted growth is pastured. Prac-

tically all of the prussic acid disappears as the fodder is being cured. Varieties having a low, nontoxic level of prussic acid are being developed to overcome the hazard.

In the Southeastern States the sorghums are susceptible to several leaf diseases which reduce their feed value.

#### SUDANGRASS

(*Sorghum vulgare* var. *sudanense*)

Sudangrass was introduced into the United States in 1909 from Africa. Its widespread adaptation to many regions here have made it one of the most valuable of summer annual forage grasses. Like the sorghums, it tolerates droughty conditions and its rapid growth from late seedlings makes it an ideal emergency forage for pasture, hay, or silage.

Sudangrass grows 4 to 7 feet tall, depending on method of planting and fertility. The stems, of which many arise from a single clump, are relatively fine but erect; they seldom become much larger than a lead pencil. The numerous leaves are long and narrow; the heads are composed of loose-bending branches 6 to 18 inches long.

Sudangrass usually is grown alone in places that have limited soil moisture; where rainfall is adequate it is frequently grown with soybeans. Yields of forage, depending upon rainfall and soil fertility, range from 1 to 7 tons an acre; likewise, yields of seed may vary from 250 up to 2,000 pounds.

Sudangrass occasionally may contain enough prussic acid to be toxic to livestock, although the risk is not so great as in the sorghums, particularly in northern latitudes. Short, stunted growth usually contains more prussic acid than normal growth.

If humidity and temperatures are high, Sudangrass is attacked by several leaf diseases that reduce its value.

There are several varieties of Sudangrass—one is resistant to certain leaf diseases, another combines the sweet-stem characteristic of sweet sorghum with the fine stems and leaves of com-



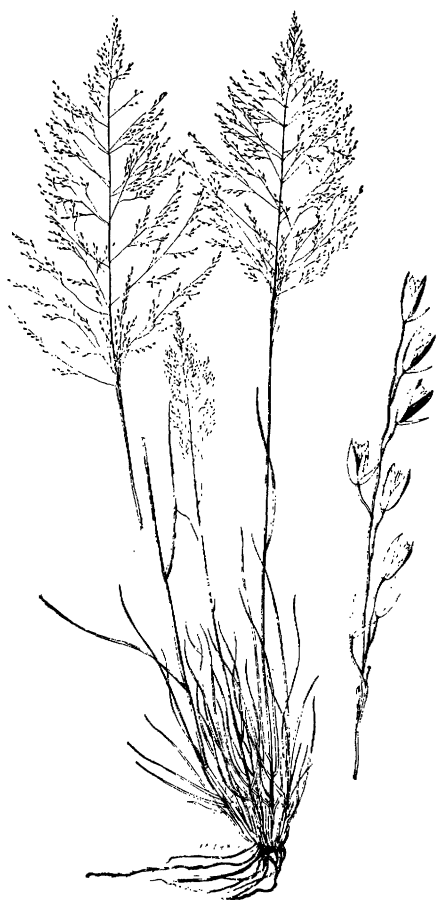
Sudangrass

mon sudan, and still another, now being developed, is nearly free from prussic acid.

#### JOHNSONGRASS

(*Sorghum halepense*)

Johnsongrass is different from all other species of sorghum in that it is a perennial that spreads by vigorous



Alkali sacaton

rootstocks. The stems, leaves, and heads of Johnsongrass resemble those of Sudangrass, although it seldom grows so tall. It was brought from Turkey about 1830, and has spread throughout the South.

Johnsongrass grows wherever cotton is produced and thrives where moisture is abundant. Its seed fertility is high. Two and three crops of hay are frequently harvested a season; yields of more than 15 tons are common. It is valuable for pasture and is grown with several winter annual legumes. Yields of seed may reach 8 to 10 bushels an acre.

Johnsongrass may contain small quantities of prussic acid, but rarely are

livestock poisoned by it. Johnsongrass is condemned by many people, but it does have a profitable place in livestock production in many sections of the South.

## DROPSEEDS

(*Sporobolus* species)

The *Sporobolus* genus is large and widely distributed. The species native to the United States number 36 and are most abundant in the Southern Great Plains and the Southwest. The scientific name is derived from the Greek *spora*, seed, and *ballein*, to cast forth; the common name, dropseed, refers to the prompt casting of seed as it nears maturity.

Spikelets of *Sporobolus* are single-flowered. In most species the stems are solid or pithy, rather than hollow. Most of the perennial species are palatable to animals.

Practically all the dropseeds produce an abundance of viable, long-lived seed that—because of a hard, impervious seed coat—may lie dormant many years before germinating under natural conditions; that characteristic is sometimes an advantage and accounts for the appearance of seedlings after long periods of drought.

## ALKALI SACATON

(*Sporobolus airoides*)

Alkali sacaton is a densely tufted, long-lived, native bunchgrass that occurs generally throughout the western and southwestern sections.

The seed stalks are erect, smooth, solid, and about 3 feet tall. The seed heads are open panicles that terminate in single florets.

The foliage is basal and abundant; the leaves are about one-fourth inch wide and 8 to 18 inches long. The roots are coarse and fibrous and penetrate the soil to good depths. The grass is commonly found on moist alkaline soils but it occurs also on other types of soil. Normally the stand has a distinctive tufted or bunchy appearance.

Alkali sacaton produces much forage, which is eaten freely by cattle and horses during the growing season. As the plants mature, however, the foliage becomes coarse, tough, and unpalatable and does not cure into nutritious winter feed. Grass that is kept closely cropped affords good grazing. It produces hay of fair quality if cut at the proper stage of development.

Seed is ordinarily obtained from native stands, no doubt because of the general abundance of the species over wide areas. Nearly always a satisfactory seed crop matures at some place each season. Seed can be harvested with a combine or by threshing mature seed hay. Seed of excellent quality has been produced under cultivation, but the procedure seems unnecessary as long as native stands are a dependable source.

#### SAND DROPSEED

(*Sporobolus cryptandrus*)

Sand dropseed is a tufted, widely distributed, native grass. It occurs most abundantly in the Southern Great Plains and the Southwest. It is a pioneer or invader species on raw, denuded soil and is most prevalent on sandy soil.

Plants grow about 2 to 3 feet tall, with solid stems and fairly numerous leaves about one-fourth inch wide and 4 to 12 inches long. Seed heads are open, the finely branched panicles average 8 to 12 inches in length and terminate in single spikelets. Characteristically, many of the seed heads remain within the upper portion of the surrounding sheath, so that the plants tend to retain large portions of their seeds. Roots are coarse, fibrous, and penetrating—a characteristic that accounts partly for the wide adaptation of the species.

Sand dropseed produces a fairly large amount of foliage, which is taken readily by livestock while green but only sparingly after the plants reach maturity.

It is a prolific seeder and, when protected or properly grazed, tends to in-



Sand dropseed

crease in density on the depleted range.

Seed matures in late summer and is readily harvested with a small grain combine. When the grass has been grown in rows and cultivated or grown under irrigation, exceptionally high yields have been obtained exceeding 1,000 pounds an acre.

Its widespread occurrence has encouraged its use for revegetation. It is generally recommended for seeding in mixtures with adapted species at about 1 pound per acre. Because of the small size of the seed (usually more than 5 million in a pound), planting should be shallow and the new seeding should be protected during the period of seedling establishment.

Many excellent characteristics make it valuable for revegetation use. It is widely adapted as to soils and climate;

forage production is satisfactory (although not outstanding in its total amount or quality); seed production is excellent under most conditions; and the delayed germination appears to be a useful characteristic for any species that must withstand wide extremes of climate.

Sand dropseed, like other species of the genus, has hard seed, which ordinarily do not germinate unless scarified or treated with acid to make the seed coat permeable or held in dry storage for at least a year.

### ST. AUGUSTINEGRASS

(*Stenotaphrum secundatum*)

St. Augustinegrass, now found along the southern Atlantic coastal regions, is an extensively creeping, rather coarse, and glabrous perennial that produces stolons with long internodes and branches that are short, rather leafy, and flat.

The sheaths are flat and folded; the blades short, 4 or 6 inches long and obtuse; the flowering culms are 4 to 12 inches tall. The flower spikes are 2 to 4 inches long, both terminal and axillary.

In the region where it is adapted, it thrives in shaded areas so it is especially useful for lawns. On many golf courses in the South it is used on fairways. It is naturally a seashore plant and will withstand salt spray.

It is native to the West Indies. In Cuba it is called *camalote*, *gramon de costa*, and *canamazo amargo*. It is also found in Upper and Lower Guinea, Africa, and in South Africa from Cape Town to Natal. In the Pacific area, from southern Mexico to Australia, it is also native. It has been introduced into southern France and Italy. In the Hawaiian Islands it was formerly called *Manienie*, a native name that is now applied to Bermuda-grass there. In British Guiana it is sometimes called sheep grass.

St. Augustinegrass affords good pasturage but it has not been used extensively for that purpose. It is used for



St. Augustinegrass

grazing on muck soils in the Everglades in Florida, where it furnishes more grazing than such grasses as Para, which is commonly used there. The creeping, flat stems of St. Augustinegrass root to form dense sods which stand trampling.

Because practically no seed is produced, vegetative material must be used in making new plantings. Rooted runners, used for this purpose, are planted in rows or disked into the soil

during moist periods, and subsequently packed. Establishment is not difficult, and good stands are usually had.

St. Augustinegrass should be well fertilized. Nitrogen is especially essential; on sandy land it will require annual applications. Ample moisture is also necessary for best growth and development.

This grass is subject to brown patch fungus, which does most damage in warm weather when there is undue moisture. The disease is controlled rather easily by stimulating growth of the plant with nitrogen fertilizers or by using calomel and corrosive sublimate. (Care should be exercised by anyone who uses corrosive sublimate, a virulent poison.) But so far the disease has not been a serious factor in growing the grass.

Chinch bugs also may do damage. Small brown areas that soon widen indicate their presence. Known remedial measures consist of blowing tobacco dust down between the stems of the grass by means of a dusting machine or spraying with nicotine sulfate (a poison!), using 1 part of nicotine sulfate to 500 parts of water.

## STIPAS OR NEEDLEGRASSES

(*Stipa* species)

The *Stipa* genus is distributed through the temperate zones. About 30 species grow in the Western States. The scientific name *Stipa* is from the Greek word *stupe*, tow, referring to the feathery awns of some species. Each spikelet has one flower and terminates in a prominent awn that accounts for the common name "needlegrass," that often is used for the various species of this genus.

Stipa grasses rank fairly high as forage grasses on the western ranges because of their abundance, wide distribution, long growing period, and capacity to cure well on the ground.

The injuries that the long, sharp awns cause on grazing animals are a serious objection to these grasses regardless of their other virtues.

## NEEDLE-AND-THREAD

(*Stipa comata*)

Needle-and-thread is a deep-rooted, long-lived, native bunchgrass that occurs generally on the western ranges and most abundantly on the sandy soils of the Northern Great Plains. It grows in almost pure stands as an invader on some of the abandoned croplands of the Plains. It derives its name from the appearance of the seed, which is sharp-pointed and has a long, bent, twisted, threadlike awn that looks like a threaded sewing needle.

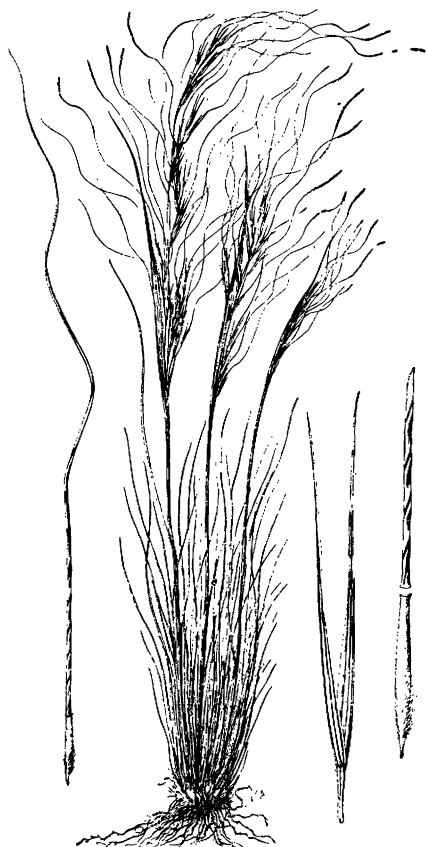
Seedstalks grow 1 to 4 feet high, with leaves less than one-eighth inch wide and 8 to 12 inches long. Leaf auricles are absent, but the ligule is membranous, notched, and prominent. Seed awns, also prominent, usually average 6 inches or more in length.

Growth starts in early spring, usually before associated native grasses green up, and continues throughout the summer if enough moisture is available. Growth is resumed after a drought if favorable moisture and temperatures are present in the fall.

Flowering of this species usually begins early in June, and the seed matures and is shed in July. Livestock graze the plants sparingly during this period. Palatability is reduced by the sharp points of the seeds, which injure livestock by working into the mouth parts and the hide. Except for the period when seeds are present, livestock eat the forage readily. They make good use of the standing cured forage for winter grazing.

Seed is produced in abundance most years, but the heavy awns and sharp points on the seed make it difficult to handle. Seeding is almost impossible with an ordinary grain drill, because the long awns cause the seed to mat into large clumps that clog the seeding spouts. Processing the seed with a hammer mill to remove awns improves its quality.

Although this grass has wide adaptation in the Plains, it has been used only sparingly for reseeding, mostly because



Needle-and-thread

of objections to it for grazing and difficulties in handling the seed during seeding operations.

#### GREEN NEEDLEGRASS

(*Stipa viridula*)

Green needlegrass, known also as feather bunchgrass, is a rather coarse, leafy, native perennial adapted to the Western States. It is most abundant on the upland prairie and ranges of the Northern Great Plains. It is seldom found as the major constituent in the native association except where it receives additional moisture from flooding or where it invades abandoned cropland. It seems to be well adapted to most soil types but makes its best growth on the sandier soils.

Green needlegrass grows to a height of 3 feet. Its leaves, mostly basal, vary in width from one-fourth to one-half inch, and in length from about 8 to 12 inches. The seed heads are compact panicles about 4 to 8 inches long. Seed spikelets have short, bent awns about an inch long that are conspicuous, but not nearly so troublesome to grazing animals or in seed handling as the awns of needle-and-thread grass. The green needlegrass has rather deep, fibrous, penetrating roots, which fact accounts for its wide adaptation.

Growth starts early in the spring and continues into the fall when enough moisture is available. It makes excellent recovery after grazing or clipping and provides good pasture forage for all classes of livestock. Hay of excellent quality may be produced. If the plants are permitted to stand, fairly good winter grazing is furnished.

Seed of green needlegrass matures in early July. For seed production the grass can be harvested with a binder, header, or swather, then cured and threshed. Seed heads are indeterminate in ripening; hence these methods of harvesting will give the smallest amount of undeveloped seed in the threshed seed material. Seed yields of 150 pounds an acre have been obtained from natural stands. Yields of 300 to 500 pounds have been obtained from plants in rows and cultivated.

The seed awns of green needlegrass are not so large or troublesome as those of other *Stipa* species and can be removed readily by processing the seed with a hammer mill and cleaning it in a fanning mill. The seed should then have a purity of 98 percent. The low germination of freshly harvested seed is due to a high percentage of dormant seed. Dormancy may be overcome by mechanical scarification, treatment with acid, or dry storage for a year.

Green needlegrass is a good native species for use in revegetation. The young seedlings are vigorous and fairly resistant to drought and insects. Customarily this grass is seeded in mixture

with one or another adapted species.

Plant selection and breeding with this species at the Mandan Field Station in North Dakota has resulted in development of a new variety named Green Stipa grass; it has excellent seedling vigor, a high degree of disease resistance, and good yields of forage and seed.

## THE ZOYSIA GRASSES

(*Zoysia* species)

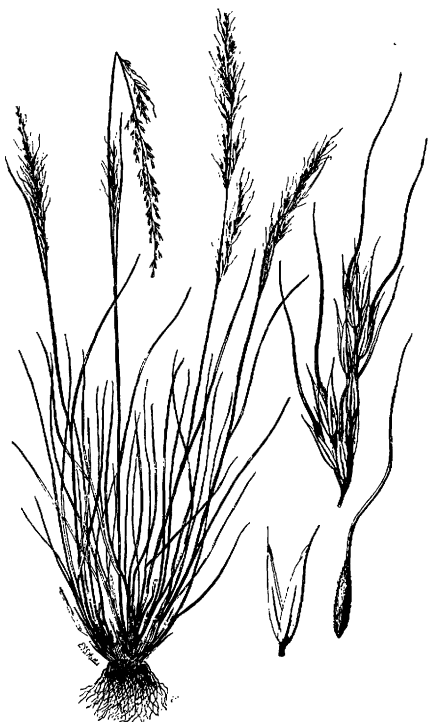
There are three species of *Zoysia* in the United States, Manilagrass (*Z. matrella*), Japanese lawngrass (*Z. japonica*), and Mascarenegrass (*Z. tenuifolia*). All are natives of tropical or eastern Asia.

Mascarenegrass, the smallest, finest, and least hardy of the *Zoysia* species, is of least importance. It seldom grows more than 2 inches high and the plants have a shallow root system. It has been grown somewhat in the South and as far west as California.

Japanese lawngrass has a broad, coarse leaf similar to that of redtop. It does not grow so tall as redtop but makes a dense cover. It is the most winter-hardy of the three species and has been grown successfully as far north as Boston. Because seed is not available, it has to be established vegetatively. Therefore, it is not now being recommended generally; it is of value for lawn or turf purposes only. It is tough, harsh, and unpalatable, and, once established, extremely hardy and persistent.

Manilagrass is the most important and widely used of the *Zoysias*. It turns brown with the first heavy frost in the fall and does not renew growth until after the last heavy frost in the spring. Near the District of Columbia, it remains green from mid-April to late October. It has survived the winter as far north as Rhode Island, but its general limit of northern adaptation is approximately 40° latitude. It will tolerate some shade, especially in the South.

Manilagrass is not very exacting in its



Green needlegrass

soil requirements, but it appears better adapted to the heavier-textured soils. Complete fertilizers in regular applications are necessary to establish and maintain good turf. The same methods of seedbed preparation are recommended as for other lawn grasses.

Seed is not available in commercial quantities, and vegetative planting is necessary. One square yard of thick sod is sufficient to sprig-plant 750 to 1,000 square feet, with rows 8 to 10 inches apart and sprigs 3 inches apart in the row. Because the plants are sensitive to cold, it is best to establish Manilagrass in the spring as soon as the soil is warm.

One of its principal weaknesses is its slow growth. It usually requires at least 2 years to obtain a good cover at the rate of planting recommended. Kentucky bluegrass, redtop, or similar grasses may be seeded between the rows of Manilagrass sprigs to control weeds (unless hand weeding or culti-



Manilagrass

vation is practiced) until the Manilagrass is established.

Considerable selection and improvement work is being conducted with Manila and Japanese lawngrass to develop superior turf strains, and it is likely that good seed-producing strains can be obtained. With seed available, the establishment of stands will be much less of a problem.

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